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# U. S. DEPARTMENT OF AGRICULTURE

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## DISEASES <sup>and</sup> <sub>of</sub> INSECTS GARDEN VEGETABLES

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follows



# CONTENTS.

	Page.		Page.
Plant diseases and insects.....	1	Principal insects and diseases,	
General crop pests.....	2	etc.—Continued.	
Cutworms.....	2	Onions—Continued.	
Aphids, or plant-lice.....	3	Onion thrips.....	28
Leafhoppers.....	4	Onion maggot.....	29
Blister beetles.....	4	Peas.....	30
Flea-beetles.....	5	Pod-spot.....	30
Grasshoppers.....	5	Stem and root rot.....	30
Wireworms.....	5	Pea aphid.....	30
Red spiders.....	5	Pea weevil.....	30
Slugs and snails.....	6	Four-spotted bean weevil and cowpea weevil.....	31
Damping-off.....	6	Potato.....	31
Root-knot.....	7	Scab.....	31
Principal insects and diseases		Late-blight.....	31
that attack garden crops.....	8	Early-blight.....	32
Asparagus.....	8	Wilt and dry-rot.....	33
Rust.....	8	Mosaic and leaf-roll.....	33
Asparagus beetles.....	8	Colorado potato beetle.....	34
Beans.....	9	Blister beetles.....	34
Pod-spot, or anthracnose.....	9	Flea-beetles.....	34
Blight.....	10	Sweet potatoes.....	35
Mosaic.....	10	Stem-rot.....	35
Rust.....	10	Black-rot.....	35
Weevils.....	10	Sweet-potato weevil.....	35
Bean leaf-beetle.....	11	Tortoise beetles.....	36
Mexican bean beetle.....	11	Tomato.....	36
Bean aphid.....	12	Wilt.....	36
Beets and chard.....	12	Leaf-spot.....	37
Leaf-spot.....	12	Blossom-end rot.....	37
Beet flea-beetle.....	13	Tomato worms, or horn-	
Beet webworms.....	13	worms.....	38
Cabbage.....	13	Tomato fruitworm.....	39
Clubroot.....	13	Flea-beetles.....	39
Yellows, or wilt.....	14	How to make fungicides and in-	
Black-rot.....	15	secticides.....	39
Black-leg.....	16	Fungicides.....	39
Common cabbage worm.....	17	Bordeaux mixture.....	39
Cabbage looper.....	18	Bordeaux dusts.....	40
Harlequin cabbage bug.....	18	Mercuric chloride.....	40
Plant-lice.....	18	Formaldehyde.....	40
Flea-beetles.....	19	Insecticides.....	41
Cabbage maggot.....	19	Lead arsenate.....	41
Celery.....	20	Other stomach poisons.....	41
Leaf-blight.....	20	Nicotine sulphate as a	
Celery leaf-tyer.....	21	spray.....	41
Celery caterpillar.....	21	Nicotine sulphate as a	
Cucumbers, muskmelons, and		dust.....	42
squashes.....	21	Soap sprays.....	43
Wilt.....	22	Pyrethrum.....	43
Mosaic.....	23	How to spray.....	43
Anthracnose.....	23	Spraying and dusting tools.....	44
Downy mildew.....	23	Miscellaneous control meth-	
Angular leaf-spot.....	23	ods.....	44
Leaf-spot.....	24	Soil disinfection.....	44
Striped cucumber beetle.....	24	Lime.....	44
Twelve-spotted cucum-		Flowers of sulphur.....	45
ber beetle.....	26	Carbon disulphide.....	45
Melon aphid.....	26	Trap crops.....	45
Common squash bug.....	27	Beneficial insects.....	45
Squash-vine borer.....	27	Lady-bird beetles.....	45
Onions.....	28	Syrphus flies.....	46
Smut.....	28		

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# DISEASES AND INSECTS OF GARDEN VEGETABLES.

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## PLANT DISEASES AND INSECTS.

**F**ROM THE TIME the seeds of garden crops are put into the ground until the crops are gathered, diseases and insects may appear that must be fought. Vegetable troubles are due to numerous causes, including unfavorable soil conditions, too wet or too dry, too rich or too poor, lack of humus or of lime, weather unsuited to some crops, careless use of fertilizers, or attacks of fungi or other parasites. The adoption of the best horticultural practice—crop rotation, the careful application of fertilizers suited to each crop, adequate cultivation, the planting of all crops in their proper season—is important for the successful growing of garden crops. The control of diseases due to fungi, bacteria, and other enemies requires special additional treatment, as does the damage caused by insects. The purpose of this bulletin is to present briefly control measures for the more important insects and fungous and bacterial diseases of the home-garden vegetable crops.<sup>1</sup>

The use of disease-free seed and plants is fundamental to all insect and disease control. A modified application of the principle of crop rotation can be made even in the home garden by moving the rows of each vegetable to another place every year. Many diseases and insects live over winter in the soil and will appear on the plants again next season if they are in the same soil. Furthermore, since many of the pests of closely related crops are the same, such vegetables should not be planted in succession. Vine crops should not follow any vine crop, nor should crucifers follow each other.

Numerous important diseases are carried in or on the seed and can not be controlled by seed treatment, such as bean anthracnose, pea pod-spot, and potato leaf-roll and mosaic. It is therefore essential to secure the most disease-free seed obtainable.

Some of the worst garden troubles, such as root-knot and club-root, are brought in on the roots of plants and not only damage the present crop but remain in the soil to attack future crops. In buying plants one should be sure they are healthy and free from insects. The roots should be clean, hairy, and free from knots or swellings. "Prevention is better than cure," especially in the home garden, which usually must be planted on the same ground year after year.

<sup>1</sup> For a more complete discussion of the diseases and insects attacking special crops or for information on the methods of growing garden crops the reader is referred to other department publications.

Injurious insects may be divided into two classes with reference to their manner of taking in food. Caterpillars, beetles, grasshoppers, and grubs have biting mouth parts and feed by biting off, chewing up, and swallowing the substance of the plant. On the other hand, the mouth parts of plant-lice, thrips, leaf hoppers, and plant bugs form a tubular beak through which the juices from within the plant are sucked up and swallowed. On this account, the latter are not affected by arsenicals or other stomach poisons which may be applied to the surface of the plant, but must be controlled by contact insecticides, or remedies which kill by actually touching the insect.

In growing to maturity insects may pass through two different series of changes. Plant-lice, thrips, grasshoppers, leaf hoppers, and plant bugs are hatched from the egg in a form which resembles that of the full-grown insect, usually, however, without wings, although the adult may be winged. On the other hand, newly hatched beetles, moths, and flies first appear in the forms variously known as grubs, caterpillars, and maggots. After passing a variable time in this stage they enter an inactive period, known as the pupa or chrysalis, and in due time cast off their protective covering to become full-grown beetles, moths, and flies. The gardener should become familiar with the different stages of the destructive pests which, taken together, require almost daily repressive measures during the growing season.

In presenting the methods of controlling insects and diseases in the following pages, they are discussed under two headings, "Treatment" and "Prevention."

Under "Treatment" are discussed the methods of control which may be applied after the diseases or insects have appeared in the garden, such as the use of poisoned bait for cutworms, the hand picking of insects, burning diseased plants, or spraying with Bordeaux mixture and arsenicals for disease and insect control.

Under "Prevention" are included all measures of control applied prior to disease or insect appearance which will tend to hinder or stop the development of diseases and insects or prevent their overwintering to attack the next season's crops, such as planting disease-resistant, disease-free, and weevil-free seed, treatment of seed to kill insects and diseases, or the planting of crops on parts of the garden free from these pests.

### GENERAL CROP PESTS.

While many plant diseases and insects attack only one crop or a group of related plants, there are some which may attack almost any of the garden vegetables. The most important diseases in this class are damping-off and root-knot, and among insects are cutworms, plant-lice, blister beetles, flea-beetles, grasshoppers, wireworms, red spiders, and slugs and snails.

#### CUTWORMS.

The smooth, gray and brown cutworms (fig. 1) are well known to most gardeners. They are the offspring of obscure brownish moths. They hatch from eggs laid in late summer. They reach considerable size before the winter, which they pass as caterpillars, often appear-

ing in great numbers in early spring and summer, hungry from their long fast. Since they feed by night, they are capable of killing many small plants before the gardener observes their presence. The main injury done is the cutting off of the stems of young plants at the surface of the ground, although certain species climb small plants and cut only the leaves. One cutworm can kill many plants in a night.

*Treatment.*—The best remedy is poisoned bait, made for use in a small garden by thoroughly mixing two level tablespoonfuls of white arsenic or Paris green with 5 pounds of dry bran. Then add from 4 to 6 quarts of water in which a half pint of sorghum or cheap molasses has been mixed. After the mash has stood for several hours, scatter it thinly over the garden or about the bases of the plants that have been set out. The best plan is to mix the poison in the morning and to apply it late in the day, so that it will be moist and attractive when the cutworms come forth in the evening to feed. The treatment may be repeated if all of the cutworms are not destroyed by the first application. As this mash is poisonous, young children, livestock, and poultry should be kept away from fields where it has been applied.

Hand picking also is effective in small gardens. The cutworms usually conceal themselves near the base of the plant which they have destroyed and may be found curled up about an inch below the surface of the ground within 3 or 4 inches of the cut plants. Several may be found about one plant.

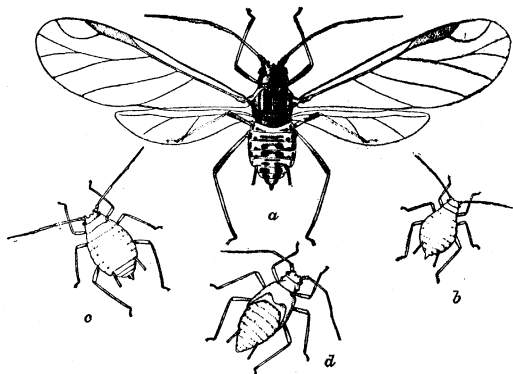


FIG. 2.—The spinach louse, showing full-grown louse and young ones. Greatly enlarged. (Chittenden.)

the twigs or shoots and on the under sides of the leaves of a great variety of plants, where they feed on the sap and often cause serious injury by curling the leaves or weakening and killing the young shoots. The young are born alive—several often being produced daily—and these mature in a few days. Under ordinary conditions practically all produced are females, and the rate of increase is

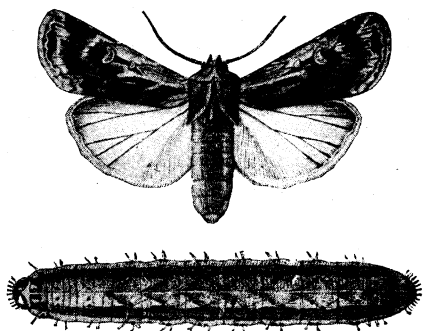


FIG. 1.—Granulated cutworm. Moth above; cutworm, or larva, below. Somewhat enlarged. (Chittenden.)

#### APHIDS, OR PLANT-LICE.

Small soft-bodied insects, known as aphids, or plant-lice (fig. 2), usually green, but varying to pink, brown, or black, are often seriously injurious to plant life, collecting on the ends of

tremendous. Plant-lice ordinarily become more injurious during cool, damp weather, being held in check during warm, dry weather by various natural enemies, important among which are ladybirds and syrphus flies.

*Treatment.*—In the treatment of plant-lice an ounce of prevention is better than a pound of cure. On their first appearance in the garden, it is advisable to apply a spray of nicotine sulphate<sup>2</sup> or to dust with nicotine dust, either of which treatments should be so applied as to reach the bodies of the insects directly, as contact with the nicotine is necessary for their destruction. Strong soapsuds, fish-oil or other soaps, and kerosene emulsion are also useful. If after attack by these pests the application of remedies is neglected, the plants may soon be too far gone to justify treatment.

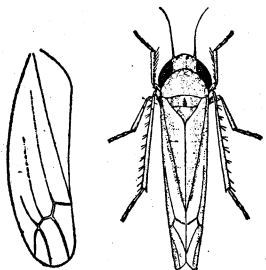


FIG. 3.—Potato leafhopper: At right, adult insect; at left, wing extended, showing venation. Much enlarged. (Chittenden.)

#### LEAFHOPPERS.

Leafhoppers (fig. 3) are slender, delicate insects, usually one-eighth of an inch or less in length, and vary from brown to pale green in color. Their name is derived from the habit of hopping to considerable distances when disturbed, after the manner of a flea. Among the crops very often attacked are potato, tomato, strawberry, and beans, the characteristic injury being a whitening and curling of the leaves, with dying of the edges. In the potato this condition is commonly called "hopperburn." The eggs are laid in the leaf tissue or stalks, and two or more broods may be produced annually.

*Treatment.*—Leafhoppers belong to the class of insects which live upon the juice of plants and can not therefore be treated with arsenicals. The application of nicotine sulphate or other contact insecticides so applied as to surround the insects when leaping or flying from the plants is a most effective remedy.

For the control of leafhoppers on potatoes the application of Bordeaux mixture is satisfactory.

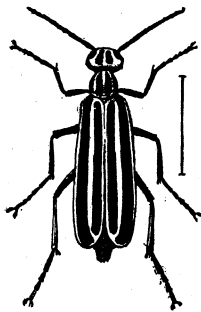


FIG. 4.—Striped blister beetle: Adult. Enlarged. (Chittenden.)

#### BLISTER BEETLES.

Blister beetles (fig. 4) are common farm pests and are often very destructive to vegetables, especially peas, beans, potatoes, and beets. They travel like armyworms, and for this reason are sometimes called army beetles. They are hungry feeders, and often travel in lines, eating everything in their path. They are slender, somewhat soft bodied, and of various colors, some being entirely black, others brown or yellow with black stripes or spots, and some dark gray or gray spotted with black. The "old-fashioned potato bug," an example of this group, is well known to most gardeners.

<sup>2</sup>Directions for preparing the different insecticides are given under the heading "Insecticides" in later pages of this bulletin.

*Treatment.*—When the beetles are first seen, spray with lead arsenate. It is often practicable to knock the beetles into pails or pans containing a small quantity of water upon which a little kerosene has been poured. Hand picking is also effective, but care should be taken to wear gloves while handling the beetles, as they may blister the tender skin.

#### FLEA-BEETLES.

Flea-beetles (fig. 5), as the name implies, are small, dark-colored beetles, which when disturbed jump away in a manner similar to that of a flea. They injure plants by gnawing small holes through the leaves, which often appear as though fine shot had been fired through them. The beetles usually feed from the under side of the leaf. In some cases the substance of the leaf is eaten through only to the upper epidermis. In some localities young seedlings when first sprouting may be seriously damaged by flea-beetles. The plants usually attacked are radishes, cabbages, turnips, tomatoes, potatoes, and eggplants.

*Treatment.*—To protect young seedlings nicotine dust may be strewn along the rows or dusted heavily over the plants. Thorough applications of Bordeaux mixture, either as a spray or as dust, or of hydrated lime alone, are also effective as repellents.

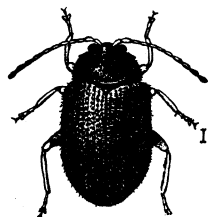


FIG. 5.—Potato flea-beetle: Adult. This species does much injury to young plants. Actual length shown by line at right. (Chittenden.)

#### GRASSHOPPERS.

Grasshoppers may prove troublesome in the vegetable garden, the time of attack varying from early spring to late fall. They often strip the leaves of beets and similar plants.

*Treatment.*—Use the same bran mash as for cutworms, adding one finely chopped orange or lemon to the water before mixing.

#### WIREWORMS.

Wireworms, the slender, hard, brown wormlike larvæ of snapping beetles or "snap bugs," often do great damage to potatoes, carrots, beets, sweet potatoes, and onions by burrowing through the roots or tubers. The burrows are small in diameter and usually extend directly into the substance of the roots to a depth of from one-fourth to one-half inch or more. Frequently the worms themselves may be found partially buried in the burrows.

*Prevention.*—Deep midsummer cultivation and heavy fertilizing will reduce wireworm damage.

#### RED SPIDERS.

Nearly all vegetables are attacked by small mites, commonly called red spiders on account of the red markings usually apparent on full-grown individuals. These mites are so small that they are not



readily seen and injure plants by sucking the juices of the leaves, so weakening them that in case of a bad attack the strength and resistance of the plant are sapped and it becomes worthless or eventually dies. In case of a bad attack great numbers of mites can be found on the under sides of the leaves, and the webs which they spin from plant to plant can be seen with the mites themselves passing rapidly over them and gathering in swarms. The plants often become seriously yellowed or appear as though scorched by fire.

*Treatment.*—The best-known remedy is to dust with sulphur. Any curling or whitening of the older leaves gives cause to suspect the presence of red spiders. Watch for them and apply the treatment when they first appear, as it is hard to save the plants after they become covered with the webs. Spray with soap and water or with 1 ounce of potassium sulphide in 2 gallons of water. Repeat in a week to catch the young after hatching. Where a stream of water from a garden hose is available, a driving forceful spray applied to the under sides of the leaves will often effectively protect attacked plants.

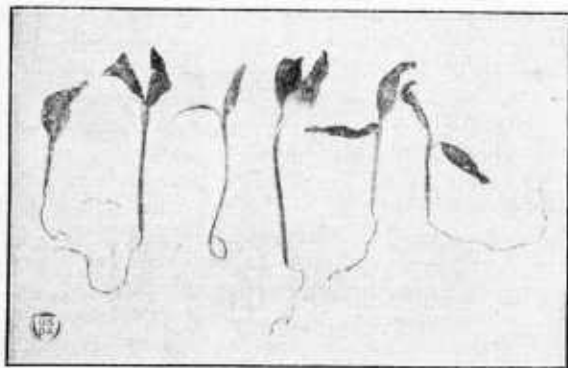


FIG. 6.—Damping-off of tomato seedlings.

#### SLUGS AND SNAILS.

These animals, which are not true insects, often do much harm in vegetable gardens, particularly in damp shady places. They eat large, ragged holes in the leaves

and may completely destroy young seedling plants grown in hotbeds and coldframes, leaving a trail of slime wherever they may have crawled. Slugs are soft, slimy animals, black, gray, or brown, and often spotted with black, looking like snails without shells. Some species reach a length of from 5 to 6 inches.

*Treatment.*—The best remedy is air-slaked lime scattered about the garden. When this comes into contact with the bodies of the slugs they throw off so much slime that they become weakened and die. Other remedies are soot, road dust, and sifted wood ashes. A strip of soot or wood ashes around the garden will often protect it.

*Prevention.*—To avoid slugs, remove all rotten wood, boards, etc., and keep the entire garden and yard free from rubbish of all kinds in which they may conceal themselves during the day.

#### DAMPING-OFF.

When seeds of tomato, cabbage, or other vegetables are planted in coldframes or in small boxes in the house to raise early plants for setting in the garden, a disease called damping-off often causes much trouble. Small plants may suddenly fall over and die, or black dead areas may appear on the stems near the soil, which dwarf or kill

the plants (fig. 6). This disease usually attacks seedlings that have been overwatered or kept too warm or have not been properly thinned.

*Treatment.*—Thin the plants where necessary, give them plenty of air and light, and keep the soil fairly dry while the plants are small, watering lightly and only early in the day so the soil will dry off quickly.

*Prevention.*—The best method of preventing damping-off and root troubles which may attack small plants is to sterilize the soil in the coldframe or seed box.<sup>3</sup>

#### ROOT-KNOT.

Southern gardens suffer greatly from eelworms, or nematodes, which cause irregular swellings or galls on the roots of nearly all vegetables. In fact, root-knot is perhaps the most widespread and serious truck-crop disease that occurs in the South, causing severe losses due to the stunting and death of many plants and a reduction of yield in others (fig. 7). It is most troublesome in sandy soils. Do not confuse this with the beneficial nodules on beans and other legumes or with the club-root of the cabbage family.

A garden infested with root-knot may produce winter crops, as the eelworms are inactive in cold weather, but for summer crops either a new location must be chosen, in which case every precaution should be taken to prevent root-knot from getting a foothold in the garden, or a system of rotation should be started to reduce the nematodes. Rotate the susceptible vegetables with corn or other immune crops. Have two or three inclosures, if possible, and alternate garden, chicken yard, and immune crops. The fowls will help the immune crops to starve out the nematodes by keeping the place free from all plant growth and will at the same time enrich the ground. Farmers' Bulletin 1345, Root-knot: Its cause and control, gives more complete information on this disease and should be secured by all who know of its occurrence in their garden or fields.



FIG. 7.—Root-knot on tomato. Similar galls occur in infested soil on the roots of many vegetables.

<sup>3</sup> Directions for carrying out the different control measures and for preparing the various fungicides referred to in the text are given under the headings "Miscellaneous control methods" and "Fungicides" near the end of this bulletin.

## PRINCIPAL INSECTS AND DISEASES THAT ATTACK GARDEN CROPS.

### ASPARAGUS.

#### RUST.

Asparagus rust is a fungous disease marked by elongated orange or black pustules on the foliage (fig. 8). The tops yellow and die early, and the next year's crop of shoots is reduced.

*Treatment.*—Rust can not be satisfactorily controlled by spraying with Bordeaux mixture or other fungicides.

*Prevention.*—Plant one of the strains of Washington asparagus, which has been bred by the Bureau of Plant Industry for rust resistance, vigor, yield, and quality. These strains are now available from many seedsmen. Other semirust-resistant varieties are Reading Giant, Argenteuil, and Palmetto.



FIG. 8.—Asparagus rust.

#### ASPARAGUS BEETLES.

The common asparagus beetle (fig. 9) is about one-fourth of an inch in length and red, black, and yellow in color. The larvæ, or grubs, as well as the beetles, feed on the foliage of full-grown asparagus and are at times injurious by gnawing and disfiguring the shoots when of cutting size. The larvæ are grayish and similar in size to the beetles.

*Treatment.*—Asparagus beetles attacking full-grown asparagus may be controlled by spraying from both sides with arsenate of lead. Should the grubs become particularly abundant, treatment with road dust or insect powder frequently will control them.

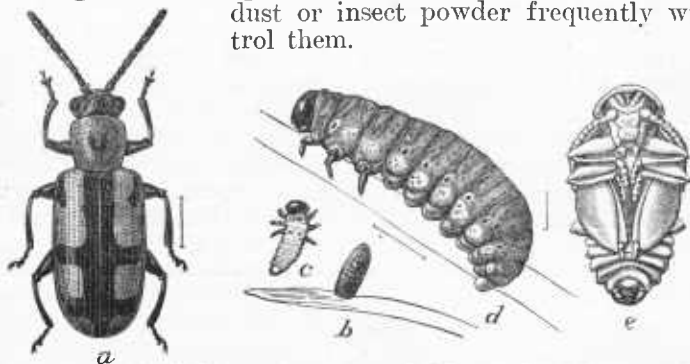


FIG. 9.—The common asparagus beetle: *a*, Beetle; *b*, egg; *c*, newly hatched larva; *d*, full-grown larva; *e*, pupa. All enlarged. (Chittenden.)

## BEANS.

## POD-SPOT, OR ANTHRACNOSE.

Most gardeners recognize anthracnose by the roundish sunken spots with dark-brown or black borders and pink centers which it causes on the young pods (fig. 10). It also produces elongated, sunken, dark-red cankers on the stems and leaf veins and grows through the pods and causes rusty-looking spots on the ripe seed (fig. 10). The causal fungus lives over winter in the seeds and attacks the young seedlings. Pod-spot is most serious in moist, cool seasons and often does not occur in dry, hot summers.

*Treatment.*—Pull and burn the first plants showing disease. Avoid cultivating or walking through the beans or

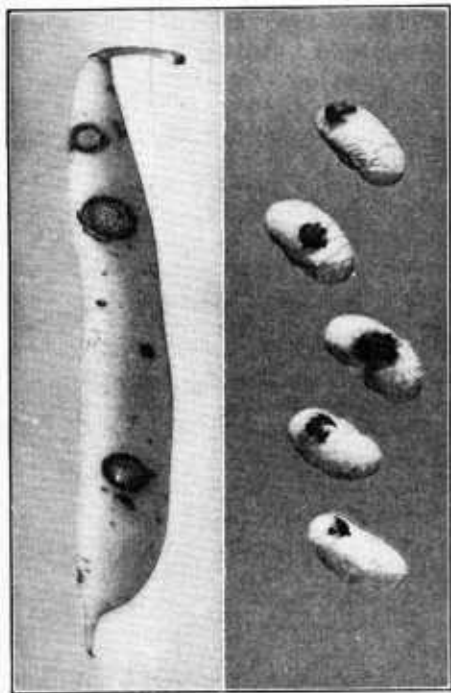


FIG. 10.—Bean anthracnose on pod and seeds. FIG. 11.—Bean blight on leaf and pod.

picking them while the plants are wet with rain or dew, as the disease is then most easily and quickly spread from plant to plant.

*Prevention.*—No seed treatment has been found successful, as the fungus is under the seed coat, where fungicides can not reach it without also killing or injuring the seed. Rotate crops. Save seed for planting from perfectly healthy pods which show no spots, or secure seed having the least possible amount of spotting and discard any showing the slightest discoloration. The anthracnose-resistant varieties, Well's Red Kidney, Western Red Kidney, White Imperial, and Nova Scotia Marrow, all belong to the dry shell-bean type.

## BLIGHT.

Bean blight, a bacterial disease, causes irregular diseased areas on the leaves, which at first are water-soaked, later become brown and

brittle, and usually have pale-yellow borders (fig. 11). It attacks the stems, producing reddish cankers, which often cause the plants to break over during storms. On the pods slightly raised watery pustules appear, which later enlarge and become irregular in shape and of rusty color (fig. 11). The disease is carried in the seed, which often becomes yellow and shriveled or shows yellow diseased blotches.

*Treatment and prevention.*—The same as for pod-spot.

#### MOSAIC.

Bean mosaic is marked by mottling of the leaves into light and dark green areas, accompanied by curling and stunting of the foliage (fig. 12) and by reduction of yield. It is carried in the seed from diseased plants and once introduced is spread by plant-lice.

*Treatment.*—Prompt destruction of the first mosaic plants seen and control of plant-lice will help to reduce the rapid spread of mosaic.

*Prevention.*—Avoid mosaic by planting disease-free seed saved from healthy plants where possible. There is a mosaic-resistant variety of the white or pea bean, named Robust, but there are as yet no resistant kinds suitable for snap or green beans.



FIG. 12.—Mosaic disease on bean leaves.

#### RUST.

The true rust here referred to is caused by a fungus closely related to that responsible for the common grain rust. It appears mainly on the leaves as tiny red pustules, which later become black, and causes the leaves to turn yellow and fall to the ground. The disease is carried in or on the seed.

*Prevention.*—Several rust-resistant varieties are available for planting in the Southern and Southwestern States, where rust often causes much loss. For dry shell beans Robust, Bird Eye, or Yellow Eye, Large-seed Bayo, and Mexican Red; for snap beans, Bush Type Green Pod, Hodson Green Pod, Late Refugee, Early Refugee, and Black Valentine; for wax-podded, Golden Eye, Hodson Wax, and Wardwell; for pole beans, Green Podded, Tennessee Wonder, Horticultural Pole; and for wax-podded, Indian Chief, Everbearing, and Mont d'Or.

#### WEEVILS.

The worst insect enemies of beans are weevils. Attack begins in the field from eggs laid on the pod. The eggs hatch into larvæ, or grubs, which at once burrow through the pod into the bean, completing their growth inside. Soon after the beans are harvested the grubs change to weevils and begin to come out. A second brood of the common bean weevil may be enough to ruin a crop of beans for either human food or seed. Several broods may be produced in a year. The common bean weevil (fig. 13) is dull gray with reddish legs and is about one-eighth of an inch long.

**Treatment.**—Bean weevils can not be controlled in the field. They breed in dry seed and it is therefore best to harvest the crop and as soon as dry to fumigate it with carbon disulphide. *Carbon disulphide gives off a gas which is explosive if brought into contact with fire.*

**Prevention.**—Plant only seed free from weevils.

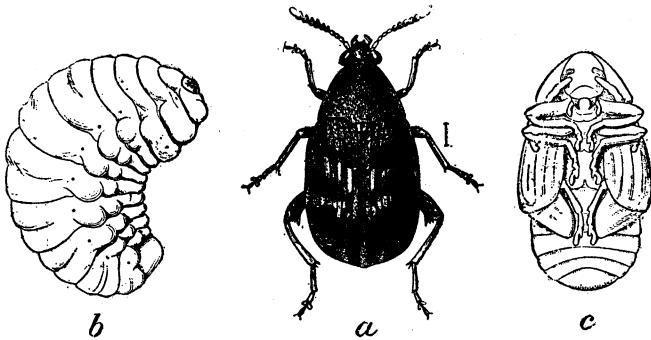


FIG. 13.—The common bean weevil: *a*, Full-grown beetle; *b*, grub; *c*, pupa. Greatly enlarged. The small straight line between *a* and *c* shows the length of the full-grown weevil. (Chittenden.)

#### BEAN LEAF-BEETLE.

The bean leaf-beetle (fig. 14) does much injury in the Eastern States and from Ohio southward to Louisiana. The beetles eat large round holes in the growing leaves, usually working from beneath. They also feed on such wild plants as beggarweed or tickseed. The grubs feed on the roots and main stems just below the ground, their habits being much the same as those of the better known cucumber beetles.

**Treatment.**—Apply the same remedies as recommended for the Mexican bean beetle as soon as the injury is noticed, to prevent the females from laying their eggs.

#### MEXICAN BEAN BEETLE.

This pest is a yellow or brownish ladybird, spotted with 16 black marks, as shown in Figure 15. It has long been present in the Rocky Mountain region and has recently appeared in Alabama, Georgia, Missis-

sippi, Kentucky, Tennessee, and the Carolinas, where it is spreading rapidly. It destroys table beans of all kinds and feeds also on cowpeas, soy beans, and some related crops. The spiny yellow larvæ, or grubs, feed on the under sides of the leaves and completely strip the plant within one or two weeks.

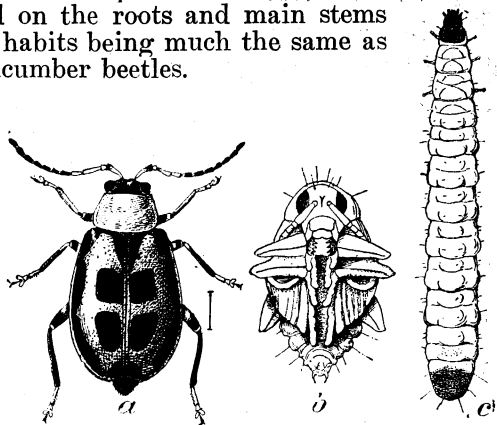


FIG. 14.—The bean leaf-beetle: *a*, Full-grown beetle; *b*, pupa; *c*, grub. Greatly enlarged. The small straight line between *a* and *b* shows length of full-grown beetle. (Chittenden.)

*Treatment.*—Bean foliage is easily injured by the usual arsenicals, so magnesium arsenate, 1 ounce to 3 gallons of water, sprayed on

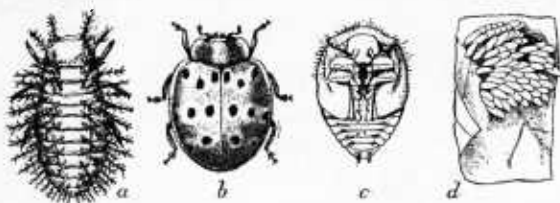


FIG. 15.—The Mexican bean beetle: *a*, Larva; *b*, beetle; *c*, pupa; *d*, egg mass. About three times natural size.

the undersides of the leaves is the best remedy. Do not spray snap beans after the pods have started to form. Pyrethrum extracts or fresh pyrethrum powder are satisfactory for small plantings if applied so as actually to touch

the insect, and for use when the crop is in the bearing state.

#### BEAN APHIS.

The bean aphid is a very small, blackish plant-louse which does damage in all parts of the United States.

*Treatment.*—Nicotine preparations provide the best remedy if put on as soon as the plant-lice are first seen and again later, if found necessary.

#### BEETS AND CHARD.

##### LEAF-SPOT.

In leaf-spot numerous small round to irregular dead spots with white centers and a purple border appear on the leaves (fig. 16). They are caused by a fungus which attacks both beets and chard, often causing the leaves to curl, dry up, and die.

*Treatment.*—For beets spray with 4-4-50 Bordeaux mixture when the first spots are noted and repeat at 10-day intervals. For chard, pick off and burn the badly spotted leaves and stimulate new growth by liberal applications of nitrate of soda.

*Prevention.*—Crop rotation.



FIG. 16.—Beet leaf, showing leaf-spot.

## BEET FLEA-BEETLE.

The beet flea-beetle (fig. 17), also called the spinach flea-beetle, is very injurious to table beets, attacking them as soon as they are above the ground. The young, or larvæ, grow on chickweed and pigweed, and a second brood attacks the beets. The young sometimes become so abundant as to destroy entire rows of beets before the insects are even seen by the gardener. They even work down and bore into the crowns of the plants. Do not use for "greens" foliage treated with a poison.

*Treatment.*—This insect can be kept down readily by spraying with arsenate of lead when the pest is first seen, and again as often as needed.

*Prevention.*—Chickweed, pigweed, and lamb's-quarters are the natural food plants of the flea-beetle and should be killed in the early spring. Cutworms also feed on these weeds.

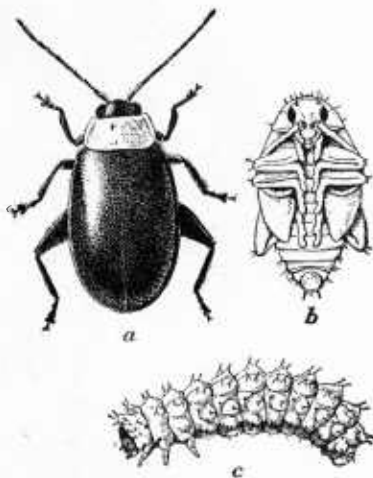


FIG. 17.—The beet flea-beetle: *a*, Beetle; *b*, pupa; *c*, full-grown grub. Greatly enlarged. (Chittenden.)

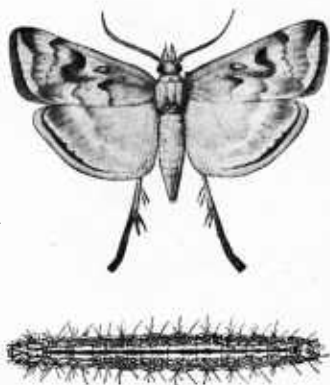


FIG. 18.—Beet webworm: Above, moth; below, full-grown larva. Enlarged. (Chittenden.)

## BEET WEBWORMS.

Several kinds of webworms attack beets by eating the leaves, which become webbed together on the growing plant. The worst of these pests, known as the beet webworm, is shown in Figure 18.

*Treatment.*—Spray with arsenate of lead.

*Prevention.*—The garden should be kept free from such pests as pigweed, since these encourage webworms and help them to spread.

## CABBAGE.

Many of the diseases which attack cabbage also cause damage to other crops of the same family, including cauliflower, turnips, Brussels sprouts, and collards, as well as some related wild plants.

## CLUBROOT.

This disease, also called fingers-and-toes, is caused by a minute slime mold which enters the roots and produces large irregular



swellings and malformations like those shown in Figure 19. Diseased plants are stunted, have a sickly yellow appearance, often wilt during the heat of the day, and generally fail to head. The trouble may attack the plants in the seed bed or after they are set out.

*Treatment.*—There is no remedy for plants once attacked by clubroot.

*Prevention.*—Rotate crops so that no crop of the cabbage family is planted on land where clubroot has occurred for several years previously, and do not allow weeds of the same family, such as mustard and shepherd's-purse, to grow there. If no clubroot-free land is available, apply lime, preferably hydrated, at the rate of 25 pounds per square rod, working it deeply into the soil several months before planting.

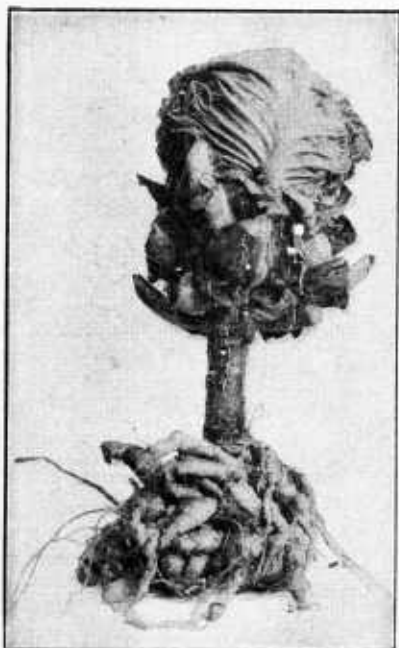


FIG. 19.—Cabbage plant with large knotted roots caused by clubroot.



FIG. 20.—Cabbage plant stunted and leaves curled due to yellows.

Take special care that only healthy seedlings are planted. If plants are home grown, sterilize the soil in which seed is planted. Burn diseased plants. Do not put them on manure or compost piles.

#### YELLOWS, OR WILT.

Cabbage plants attacked by yellows are stunted, turn a lifeless yellowish green, and the lower leaves fall off. Often one-sided plants are found (fig. 20). The disease is caused by a fungus which lives in the soil and grows into the roots and up the water vessels, causing a dark-brown ring in the stem. Often the worst diseased plants wilt, curl

up, and die soon after transplanting. Many live a month or more or through the season, but few produce heads. In many localities wilt is the most important cabbage disease and causes heavy losses in gardens and fields.

*Treatment.*—There is no treatment for diseased plants. It is a waste of time to set out plants having the disease.

*Prevention.*—Plant on uninfested soil if available, being sure that only healthy seedlings are used. If plants are home grown, sow seed only in disease-free or sterilized soil. Practice crop rotation. If the entire garden is infested with yellows, secure seed of yellows-resistant varieties, several of which are now available and are being

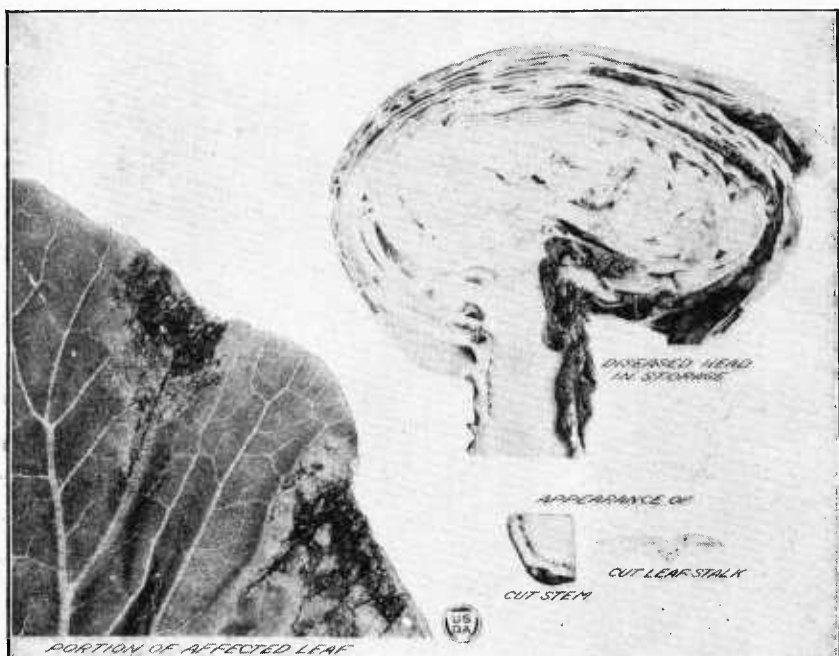


FIG. 21.—Cabbage black-rot.

handled by a number of seedsmen. The yellows-resistant Wisconsin Hollander is a late storage cabbage which has been developed from Hollander or Danish Ballhead, while Wisconsin All Seasons and Wisconsin Brunswick are flat types, somewhat earlier and specially adapted for making sauerkraut. Resistant midseason strains, Marion Market, Globe, All Head Select. and an early strain, Jersey Queen, are now available from a few seedsmen.

#### BLACK-ROT.

Cabbage plants attacked by black-rot usually have yellowed leaves with areas on the edges showing blackened veins (fig. 21), and the inside of the stems exhibits a black ring. Plants may be attacked by black-rot at any time during their growth. Affected plants may die early in extreme cases or fail to form heads. Diseased heads often rot in the field or in storage (fig. 21). Serious losses often result.

*Treatment.*—There is no treatment which will stop the disease when once started. Pulling and burning affected plants as soon as the disease is noted helps to prevent the spread of the trouble.

*Prevention.*—A long crop rotation in which neither cabbage nor related plants are allowed to grow on infested land is very important. Disinfect the seed in mercuric-chloride solution before planting (p. 40), or treat for 30 minutes in hot water at 122° F. A higher

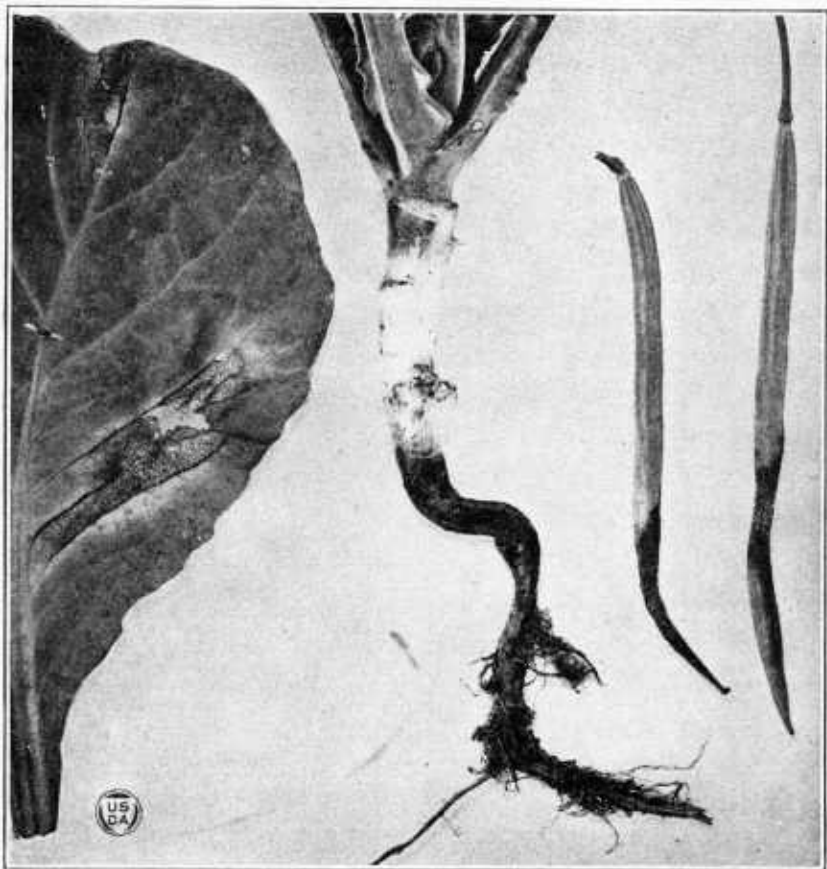


FIG. 22.—Black-leg of cabbage, showing injury and blackening of the main root and diseased spots on the leaf and seed pods, in which numerous black fruiting bodies of the causal organism are evident.

temperature may kill the seed. Plant in seed-bed soil known to be free from black-rot, or in disinfected soil.

#### BLACK-LEG.

Black-leg may attack cabbage plants while they are very small, often in the seed bed. It is caused by a fungus which produces a blackening and rotting of the stem and on the leaves dark spots in which tiny black pimples appear (fig. 22). The leaves often turn purple, and later the whole plant wilts so the tips of the leaves rest

on the ground. The disease is carried on the seed and is often spread from diseased to healthy plants in the seed bed by careless watering or by spattering during rainstorms.

*Treatment.*—Pulling and burning diseased plants as soon as found in the seed beds and avoiding the spread of the disease by careful watering and by protecting the seed bed from rain are recommended.

*Prevention.*—Follow the preventive measures suggested for black-rot.

#### COMMON CABBAGE WORM.

The velvety green caterpillar, so commonly injurious to cabbage, is known to most gardeners. Many, however, do not know that the white butterfly (fig. 23) so common in the vicinity of cabbage plants is the parent of this pest. The caterpillar becomes the white butterfly, which, in time, lays the eggs from which come a later brood of caterpillars. Cabbage worms begin work early in the season. After eating the outer leaves they attack the tender inner leaves as they form, hiding in the young heads, where it is hard to reach them with a spray. They make the cabbage heads unfit for food, partly by leaving them in a filthy condition. In cool weather the caterpillars often feed on the upper surface of the leaves, and at such times they are easily killed. The butterflies occur from March to October, and the worms are at work from April to September and later.

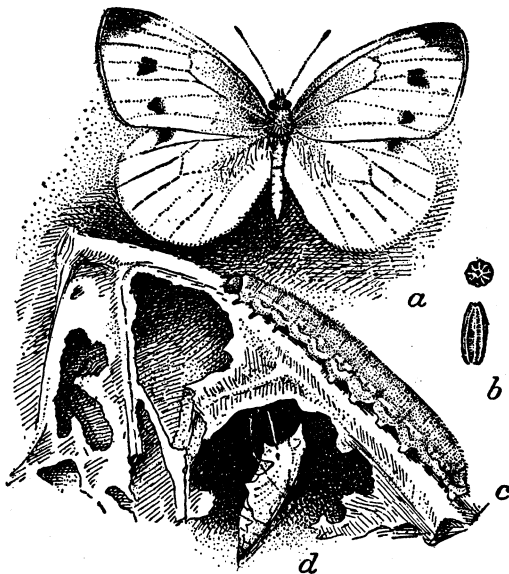


FIG. 23.—The common cabbage worm: Above, butterfly; below, cabbage worm (c) and chrysalis (d); greatly enlarged egg (b). (Chittenden.)

The cabbage worm also feeds on cauliflower, kale, collards, turnips, radishes, and horse-radish.

*Treatment.*—Spraying or dusting with arsenate of lead is the best remedy. If a spray is used, add a half-inch cube of laundry soap to each pint of lead-arsenate spray; otherwise the spray will tend to roll into droplets and will not remain on the leaves. While the spray leaves a coating on the outer leaves until late in the season, there is no danger of poisoning from this, as these leaves are always removed before cooking and whatever trace of arsenic might remain on the inner leaves is not sufficient to be injurious. Hand picking the worms will also help.

*Prevention.*—The clearing up and burning of all such weeds as mustard, shepherd's-purse, and peppergrass before planting cabbage

plants will help keep down the number of worms. Destroy all injured plants, remnants, and stalks by burning as soon as the main crop is harvested.

#### CABBAGE LOOPER.

The cabbage looper (fig. 24) is the young or worm of a medium-sized gray moth. It is pale green and delicate looking when first hatched. When larger it becomes striped, and gets its name of looper by its habit of doubling up, or looping, as it crawls. It eats all kinds of cabbagelike plants, and sometimes peas, beets, celery, and lettuce, and even attacks tomatoes and potatoes.

*Treatment and prevention.*—Same as for the common cabbage worm.

#### HARLEQUIN CABBAGE BUG.

The harlequin cabbage bug, also called the calico bug, fire bug, or terrapin bug, is about half an inch long and red, spotted with black. It is a southern insect, commonly found from Virginia to California, but often works northward.

*Treatment.*—Very strong applications of nicotine and pyrethrum sprays are of some value against the young bugs, but the full-grown ones are almost spray-proof. Hand pick the full-grown bugs and eggs early in the season. The eggs look like small black-banded barrels on end and are placed in clusters on the undersides of the leaves.

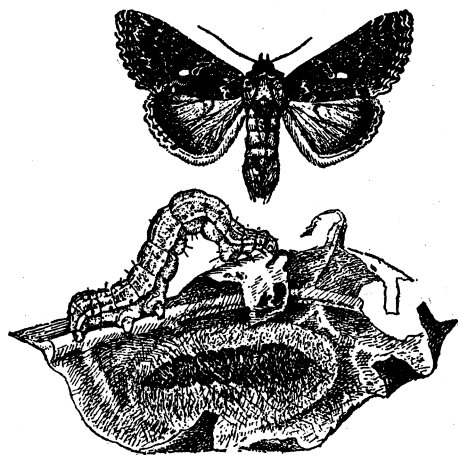


FIG. 24.—The cabbage looper: Above, moth; below, young looper and chrysalis. Enlarged. (Chittenden.)

*Prevention.*—Clean culture, especially in the fall, and planting trap crops of mustard or other plants of the cabbage family in the spring will help to prevent damage by this insect.

#### PLANT-LICE.

Plant-lice of three kinds, the cabbage louse, turnip louse, and spinach louse, do much damage to cabbage. These insects are very small, soft bodied, and greenish or yellowish. They appear early in the spring and sometimes remain as late as December.

*Treatment.*—The best remedy is nicotine sulphate. Pyrethrum extracts and soap are also good. Washing down the plants with a strong stream of water from a syringe, garden hose, or a sprayer will often keep this pest from killing them. Treatment should be given the plants when the pests are first seen.

*Prevention.*—Keep the garden clean of weeds on which plant-lice feed.

## FLEA-BEETLES.

Flea-beetles attack young cabbages, radishes, and turnips. These are usually striped or greenish or bluish black. They are a little larger than fleas and have the same jumping habit.

*Treatment.*—Use lead arsenate, as for cabbage worms. Bordeaux mixture with two 1-inch cubes of laundry soap added for the 3-gallon formula, or 2 pounds to 50 gallons, is an excellent spray to drive these insects off the plants.

## CABBAGE MAGGOT.

Cabbage and related crops often suffer badly from the attacks of the cabbage root-maggot, the young of a small fly which resembles the ordinary house fly. (Fig. 25.) The eggs are laid around the roots of young plants when first set out, and the newly hatched maggots by gnawing off the outer surfaces of the stems and boring into the larger roots and lower part of the stalks seriously injure and tend to

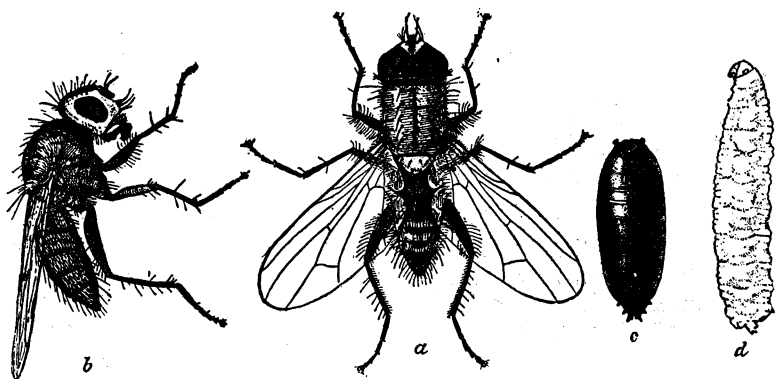


FIG. 25.—A typical root-maggot: *a*, Back view of fly; *b*, side view; *c*, puparium; *d*, maggot. Greatly enlarged. (Chittenden.)

destroy the young plants. When very common, the cabbage maggot is one of the hardest pests to control.

*Treatment.*—Bichlorid of mercury is a remedy which has been successful in considerable plantings in protecting 95 per cent or more of the plants from root-maggot injury. When used as recommended, it will not poison plants or render them unfit for consumption. To prepare the solution for use against the cabbage maggot, dissolve one-half ounce of corrosive sublimate in a pint of hot water in a glass or earthenware vessel. Dilute to 5 gallons, which will be sufficient to treat from 200 to 300 plants. Apply soon after setting out the cabbage and again about 12 days later, pouring half a tea-cupful of solution over the soil at the base of each plant.

The cabbage maggot frequently attacks radishes, rutabagas, and turnips, which may be protected by applying mercuric chlorid solution directly to the rows by means of a watering pot or similar vessel.

Another remedy of value in small gardens is the use of squares or disks of tarred paper to protect the plants against the egg laying of the fly (fig. 26). To make the protectors, cut 3-inch squares of

tarred building paper and make a slit from one side to the center and several short slits like a star at the center, as shown in the illustration. Place the square around the plant just before setting out and press the paper closely around the stem and down against the ground. The squares must fit tight to keep out the fly.

*Prevention.*—Destroy all old plants by burning in the fall.

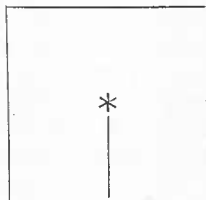
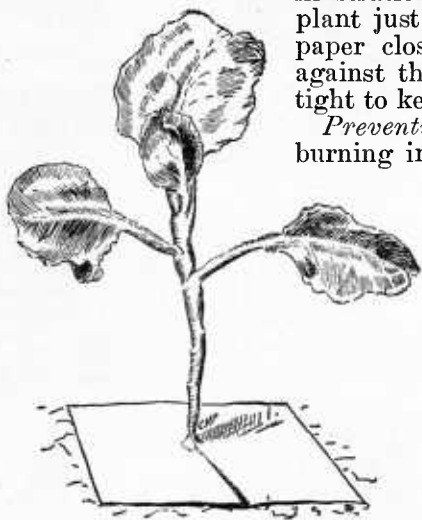


FIG. 26.—Sketches showing how tarred-paper pads are made and used to keep root-maggots from cabbage plants.

#### CELERY.

#### LEAF-BLIGHT.

Leaf-blight is a common name applied to any spotting of the leaves of celery. Three forms are fairly common and in some cases quite destructive to the crop, causing serious injury or defoliation of the plants and often resulting in shriveling or decay of the stalks after the plants are banked or put in storage. Two forms, the early-blight and late-blight, are due to fungi, and the third is caused by bacteria. Early-blight is illustrated in Figure 27.

*Treatment.*—All three forms of leaf-blight may be controlled quite effectively by careful and timely spraying with 4-4-50 Bordeaux mixture. Spraying should be begun while the plants are still in the seed bed, and after they are set in the field it should be repeated at weekly intervals. The number of spray applications will depend on local weather and disease conditions. In New York a minimum of five spray applications



FIG. 27.—Celery early-blight.

has given effective control, while in Florida 10 to 15 sprayings are

often necessary. Very thorough spraying with high pressure to cover all parts of the foliage is essential.

*Prevention.*—Crop rotation is an important means of reducing damage from leaf-blight.

#### CELERY LEAF-TYER.

The celery leaf-tyer is a caterpillar about half an inch long, pale green or whitish in color. It is the young of a yellowish brown moth about three-fourths of an inch in spread (fig. 28). It is notable through its habit of webbing together the leaves of celery and related plants. The larvæ also often feed down into the heart of the celery, injuring the stalks by cutting deep grooves in them and rendering them unfit for consumption. The small whitish eggs are laid on the underside of the celery leaves, where they may be seen with the naked eye.

*Treatment.*—Dust with a mixture composed of equal parts of pyrethrum powder and sulphur or hydrated lime. Watch for the first appearance of the larvæ and blow the mixture well down into the crowns of the plants. Repeat as often as is necessary.

Celery treated in this manner is nonpoisonous to the consumer, as the poisonous volatile oil of the pyrethrum is soon dissipated. For further information write to the Bureau of Entomology, United States Department of Agriculture.

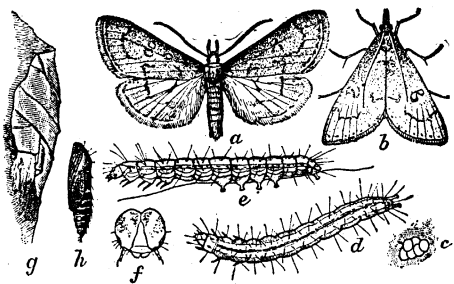


FIG. 28.—The celery leaf-tyer: *a*, Moth; *b*, same in natural position at rest; *c*, egg mass; *d*, larva from above; *e*, same from side; *f*, head of same; *g*, pupa case; *h*, chrysalis. *a*, *b*, *d*, *e*, *g*, *h*, One-half larger than natural size; *c*, twice natural size; *f*, more enlarged. (Chittenden.)

#### CELERY CATERPILLAR.

Celery and related plants are often attacked by a curious caterpillar, which when mature is about 1½ inches long and green in color, ringed closely with black. It has the strange habit of protruding two yellow filaments from near the head when disturbed. This pest is the young of the handsome black swallowtail butterfly, spotted with yellow, so often observed about celery, parsnips, and carrots.

*Treatment.*—This pest is rarely sufficiently abundant to cause serious injury. If necessary, it may be controlled with lead-arsenate spray, on all crops except celery and parsley.

#### CUCUMBERS, MUSKMELONS, AND SQUASHES.

##### WILT.

Cucumber, muskmelon, and squash plants when attacked by this disease usually wilt, dry up, and die very quickly (fig. 29). This is usually the first disease to appear in spring, often killing plants when 6 to 8 inches tall, and may continue to cause injury throughout the season. It is caused by bacteria which grow in the water vessels, thus cutting off the water supply and injuring the plants. Cucumbers are most susceptible to wilt and squashes least affected.



*Treatment.*—Pulling and burying or burning wilted vines during the early part of the season will assist in controlling wilt. Since striped cucumber beetles are the principal if not the only means of wilt spread, it is important that they be controlled by using the method given on page 24, inclosing the plants with insect-proof

cages early in the season, followed by spraying with 4-4-50 Bordeaux mixture and lead arsenate.

#### MOSAIC.

Cucumber, muskmelon, and squash plants attacked by the mosaic or white-pickle disease are stunted and have wrinkled or mottled yellow and green leaves. The yield of fruit is frequently very much reduced. The affected cucumber and squash fruits are often crooked and covered with green

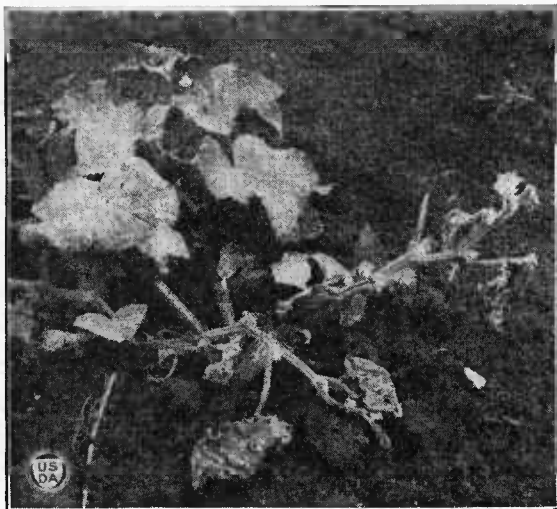


FIG. 29.—Cucumber plant attacked by bacterial wilt.

warts (fig. 30), or they may be nearly white, and when badly diseased they are not good to eat. Many affected muskmelons remain small and are not edible. The disease also attacks wild cucumbers, the common milkweed, pokeweed, and ground cherry, and possibly other wild and cultivated hosts, and lives over winter in their seed or roots. Mosaic is carried from these wild hosts to the cultivated vine crops in the spring by the striped cucumber beetles and other insects, and by them and also by pickers is spread from plant to plant in the garden.

*Treatment.*—The plants should be protected as long as possible with cheesecloth-covered cages to keep off the striped cucumber beetles (see p. 24 for details of beetle-control methods) and later sprayed or dusted as necessary to control lice and beetles.

*Prevention.*—Remove all milkweed, pokeweed, wild cucumber, ground cherry, and other wild host plants in or near the garden to prevent in so far as possible the overwintering of the disease.

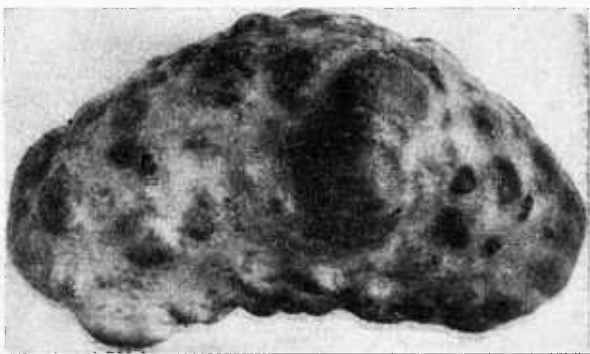


FIG. 30.—Warty cucumber affected with the mosaic.

## ANTHRACNOSE.

This fungous disease attacks cucumbers and melons particularly, causing roundish brown spots one-fourth to one-half inch in diameter on the leaves (fig. 31) and sunken elongated cankers on the stems, often killing both crops prematurely and either preventing the growth of the melons or seriously injuring their quality and causing a ripe rot of cucumbers and melons. Green melons are also sometimes attacked and round to irregular sunken spots with pink centers produced. The trouble occurs in the latter part of the season and if warm, moist weather prevails may kill the vines in two or three weeks.

*Treatment.*—Timely and thorough spraying with 4-4-50 Bordeaux mixture (p. 39) will hold the disease in check. Begin to spray as soon as the very first signs of disease are seen or soon after the vines begin to run, and continue the spraying at weekly intervals.

*Prevention.*—Since the disease lives over winter in the soil and probably also on the seed, preventive treatment is very important. Rotate so that vine crops will not follow vine crops, and disinfect the seed with mercuric chloride before planting.

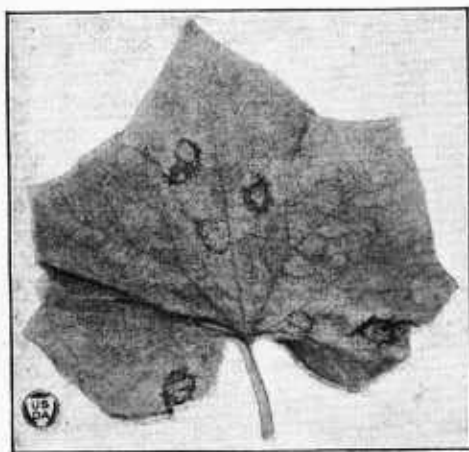


FIG. 31.—Cucumber leaf showing anthracnose spots.

## DOWNY MILDEW.

Like anthracnose, downy mildew, also a fungous disease, causes spots on the leaves of most cucurbits, which soon curl, dry up, and die. The spots are smaller, however, are yellowish above and purplish underneath, and when warm moist weather

occurs the disease kills the plants more quickly than anthracnose. No conspicuous fruit spotting is caused, but the early death of the foliage results in immature insipid fruits. Downy mildew occurs most frequently and severely in the Atlantic Coast and Southern States.

*Treatment.*—Spraying as for anthracnose will keep the plants alive two to three weeks longer than unsprayed plants live.

*Prevention.*—Rotate crops.

## ANGULAR LEAF-SPOT.

This disease, caused by bacteria, attacks particularly the leaves of cucumbers, causing angular spots one-sixteenth to one-eighth inch across. At first the spots are water-soaked; later they dry and whiten and often drop out. The cotyledons are first attacked, as the disease is seed borne. During continued wet weather in midseason considerable damage may be caused.

*Treatment.*—Angular leaf-spot can be readily controlled by spraying, as for anthracnose, but preventive treatment is much simpler.

*Prevention.*—Disinfection of seed with mercuric chloride before planting is the simplest and most effective control when combined with crop rotation.

#### LEAF-SPOT.

This fungous trouble is most serious on muskmelons, but it also attacks cucumbers, particularly in the Western States. The leaves show small irregular, brown, dead spots, and on muskmelons they soon curl up and die (fig. 32). On cucumber leaves it causes dead areas which soon fall out, leaving ragged holes and edges.

*Treatment.*—Spray with 4-4-50 Bordeaux mixture, as for anthracnose (see p. 39).

*Prevention.*—Rotate crops and where possible use resistant varieties.



FIG. 32.—Muskmelon leaf-spot.

#### STRIPED CUCUMBER BEETLE.

The striped cucumber beetle (fig. 33), as well as the twelve-

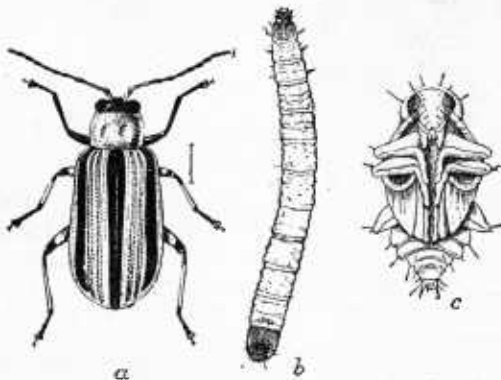


FIG. 33.—Striped cucumber beetle: a, Beetle; b, rootworm; c, pupa. Small line at right of beetle is natural length. (Chittenden.)

spotted cucumber beetle, lives throughout the eastern part of the United States. In other States there are several other kinds of beetles that have about the same habits and can be treated in the same way. The common form in the East is known as the striped cucumber beetle, sometimes called the striped bug, melon bug, or "cuke bug."

The beetle is about one-fourth inch long and is yellow, with three black stripes. The worm, or larva, is slender and white with brownish ends. Injury is done mainly by those beetles which live through the winter and eat the young plants in the spring. The beetles also injure older plants by eating the leaves and gnawing the stems and roots. They usually come out in April or May. Late in the season they gather around the stems and leaves of cucumbers, but on the

first cool nights in the fall they seek shelter. In the larva stage this insect causes damage to the roots. The beetles also spread diseases of cucumbers, squash, and melons.

*Treatment.*—The simplest protection for garden use from this and other beetles is to cover each young plant with a frame made by

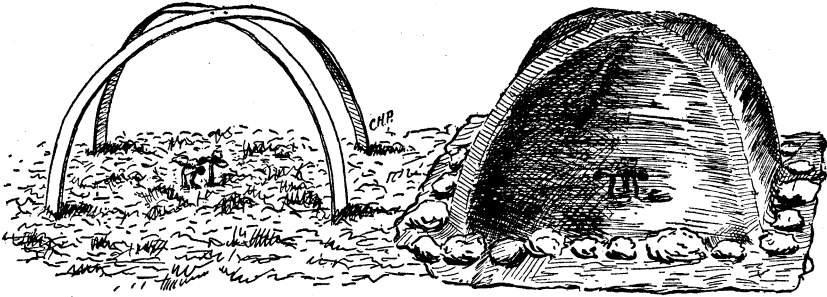


FIG. 34.—Barrel-hoop and cheesecloth cover for cucumber and squash plants to keep away insects.

placing the halves of a barrel hoop in the position shown in Figure 34 and covering the frame thus made with cheesecloth. Good cheesecloth must be used. The beetles easily go through mosquito netting, and anything heavier than cheesecloth keeps the light from the plants. The lower edges of the cloth must be held down tightly

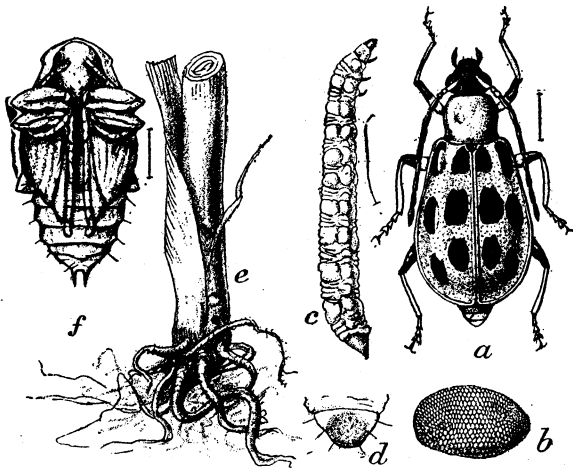


FIG. 35.—Twelve-spotted cucumber beetle: *a*, Beetle; *b*, egg; *c*, rootworm; *d*, anal segment of larva; *e*, work of rootworm on corn root; *f*, pupa. Small lines at right show natural size. (Chittenden.)

to the ground by stones or other weights or the beetles will burrow underneath. Rectangular cheesecloth-covered frames of any size and shape desired can also be made with inch-square corner pieces, to which strips of lath are nailed.

Another method is to divide the hill into quarters and each week to plant in one of the quarters enough seed for a full hill. In this way, even though

the insects attack some of the plants, there will be enough left to produce a crop. Nicotine dust, applied to the beetles gathered on the plants, care being taken that it comes in contact with the insects themselves, is also very satisfactory. A mixture of 1 pound calcium arsenate with 15 pounds gypsum or land plaster is also useful. Bordeaux mixture with lead arsenate added drives away the beetles and prevents injury to the leaves so treated.

## TWELVE-SPOTTED CUCUMBER BEETLE.

The twelve-spotted cucumber beetle (fig. 35) is a little larger than the striped cucumber beetle. This beetle often eats cucumber leaves, causing much injury. The larva lives mainly on grasses and corn.

*Treatment.*—Spraying with lead arsenate and using the same protective measures as for the striped cucumber beetle are the best remedies.

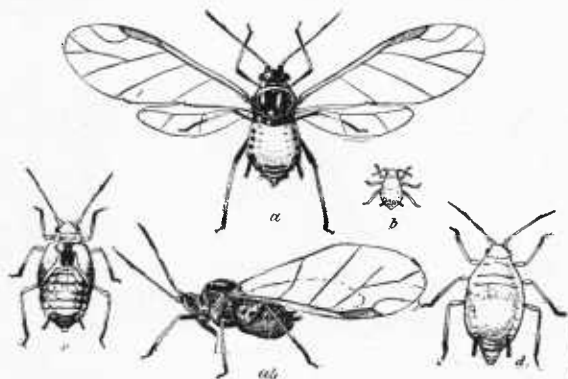


FIG. 36.—The melon aphid or louse: *a* and *ab*, Winged aphids; *b*, newborn young; *c*, nymph stage; *d*, wingless female. Much enlarged. (Chittenden.)

## MELON APHIS.

The melon aphid (fig. 36), commonly called the melon louse, is very small and greenish or nearly jet black. It sucks the juices of cucumbers and many other plants. It occurs from early spring and summer to late autumn and early winter. In seasons which favor its increase, particularly in summers following springs that are cool and rainy, it often appears in great numbers and does much damage, gathering in masses on the under sides of the leaves, causing them to curl, shrivel, and lose color, and stopping the growth of the fruit. It often kills the plants outright. An attacked melon plant is shown in Figure 37. The melon aphid gives off honeydew, a honeylike juice. When the aphids become very thick the



FIG. 37.—Melon leaves curled by the melon aphid. (Chittenden.)

It often kills the plants outright. An attacked melon plant is shown in Figure 37. The melon aphid gives off honeydew, a honeylike juice. When the aphids become very thick the

honeydew covers the leaves with a thin sticky coating on which the white skins of the aphids adhere, and this attracts attention to the injury, as do also the wilting and dying of the plants.

*Treatment.*—The best remedy is dusting with nicotine dust. Spraying with nicotine sulphate is also useful.

#### COMMON SQUASH BUG.

Squashes, gourds, and pumpkins suffer from the same pests as cucumbers. They may also be damaged by the squash bug (fig. 38), commonly known as the stinkbug on account of its disagreeable odor. It feeds on the plant juices.

*Treatment.*—Pick off the insects by hand before they lay their eggs. The shiny brown eggs are easily seen on the under side of the leaf and

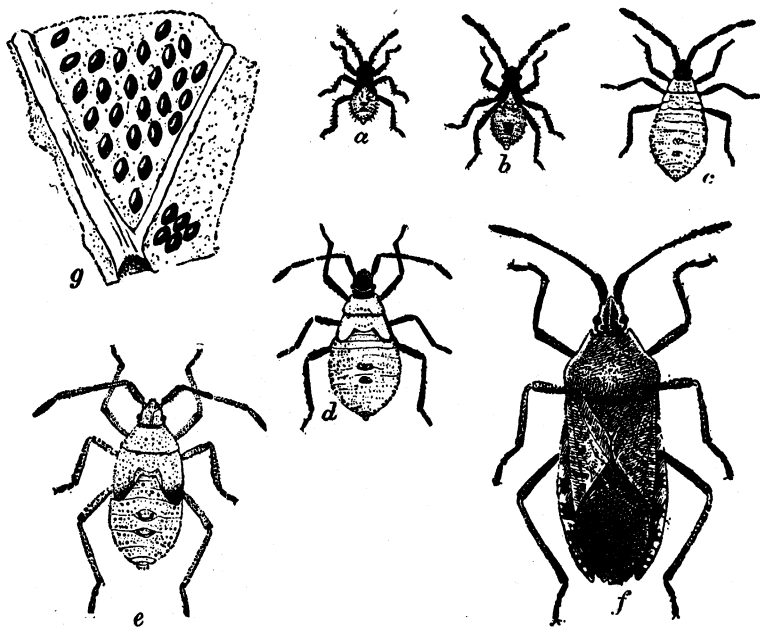


FIG. 38.—Common squash bug: *a, b, c, d, e*, Partly grown young; *f*, full-grown bug; *g*, eggs. Enlarged. (Chittenden.)

can be crushed. Cover the plants as for beetles. Use nicotine sulphate. The full-grown bugs are hard to kill, but may be trapped by placing small pieces of board, shingle, or bark on the ground near the plants. The insects will hide under these pieces of wood during the day. The traps should be examined each morning and the bugs killed.

#### SQUASH-VINE BORER.

After cucumbers and melons have made good growth they are sometimes attacked by the squash-vine borer (fig. 39), which, however, is much more destructive to pumpkins and squashes, especially the Hubbard and summer bush squashes. This is the large white

grub which bores through the stems, sometimes cutting them almost through near the roots.

*Treatment.*—When the borers attack cucumbers it is almost impossible to kill them without killing the plants. The borers may be cut out of squash vines by slitting the stems of the vines lengthwise. After slitting, those portions of the vines should be covered. Help the plant grow extra roots by covering damaged stems with earth. Keep the plants growing vigorously and free from other insects and diseases.

*Prevention.*—Plant early squash for a trap. Harrow the garden lightly in the fall and plow deeply in the spring to keep the moths from coming out. The dead vines and old plants should be destroyed as soon as the crop is gathered.

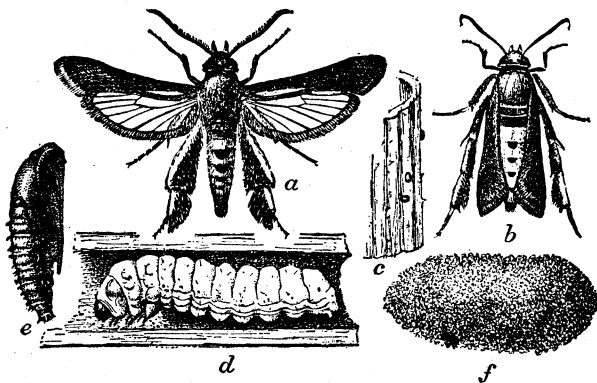


FIG. 39.—Squash-vine borer: *a*, Moth with wings spread; *b*, moth at rest; *c*, egg on section of vine; *d*, caterpillar or grub in squash vine; *e*, chrysalis; *f*, chrysalis cell from ground. Enlarged one-third. (Chittenden.)

## ONIONS.

### SMUT.

The most common and serious disease of onions is smut, which is caused by a fungus which lives in the soil where smutted onions have grown. It produces blisters full of black powder on the leaves of young plants (fig. 40), killing them and reducing the yield.

*Prevention.*—Plant onions on land where the disease has not occurred. If this can not be done, sprinkle formaldehyde solution (1 teaspoonful to 1 quart of water) in the drill after the seeds have been dropped and before covering, using 3 to 4 quarts of the solution to each 100 feet of row.<sup>4</sup>

### ONION THRIPS.

The onion thrips is a very small whitish or brownish insect, often incorrectly called onion louse, which by feeding in large numbers on the leaves causes injury known as white blast, white blight, or silvertop. The insect often destroys large fields of onions completely. It also attacks cauliflower, cabbage, cucumbers, melons, pumpkins, squashes, parsley, tomatoes, kale, turnips, and seed beets, feeding on the under sides of the leaves, which become covered with fine white

<sup>4</sup> For further details as to prevention see Farmers' Bulletin 1060.

spots, showing where the insect has withdrawn the sap of the leaf for food.

*Treatment.*—Nicotine sulphate is used with success.

#### ONION MAGGOT.

The onion maggot (fig. 41) is the worst northern onion pest. It eats into the bulb, starting decay, and often destroys the whole onion. The onion maggot is the larva of a small gray fly which looks like a small house fly. Two or three broods may be looked for each year.



FIG. 40.—Onion smut. A young plant showing blisters which later break and expose black powdery spore masses.

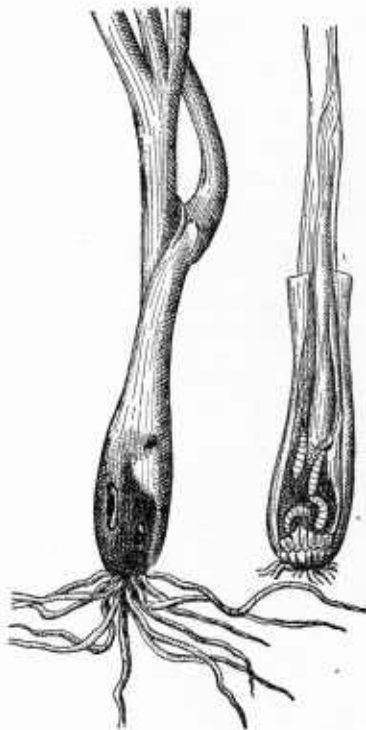


FIG. 41.—Young onion plant, showing onion maggots at work in the bulb; at right, plant exposed slightly, showing the same. (Chittenden.)

*Treatment.*—Use corrosive sublimate, prepared as recommended for the cabbage maggot and poured along the rows. When seed is sown, begin first treatment when plants are an inch high; if sets are planted, when they begin to sprout. Repeat at 10-day intervals, making from five to seven applications. After the maggots enter the bulbs treatment is useless.



## PEAS.

## POD-SPOT.

Dark spots sometimes appear on the pods (fig. 42). This trouble, called pod-spot, is caused by a fungus which also produces spots on the leaves and on the seeds, in which it is carried from one season to the next.

*Treatment.*—There is no effective treatment for a diseased crop.

*Prevention.*—Since the fungus also lives over winter on diseased vines, a long crop rotation is necessary, together with the planting of seed saved from healthy pods and showing no spots.

## STEM AND ROOT ROT.

Peas affected by this disease do not grow vigorously, often turn yellow, and sometimes die at flowering time. The stem below ground and the roots will be found decayed and yellowish brown or black in color. The yield of peas is often seriously reduced. Several fungi which live in the soil are responsible for this trouble.

*Treatment.*—No treatment is effective for diseased crops.

*Prevention.*—Rotation of crops, allowing three or more years between pea crops, is the best-known method of control.

## PEA APHIS.

The pea aphis, one of the largest of the plant-lice, is about one-eighth of an inch long and pea green. The "lice" gather in clusters about the tips of the young vine. Later they attack the stem and pods, sapping the life of the plant.

This aphis also feeds on clover, alfalfa, field peas, and several weeds.

*Treatment.*—Nicotine sulphate as a dust or spray is a good remedy if used when the insects first begin to attack the plants in early spring. The plant lice can also be beaten from the vines onto the ground, using a brush of small twigs or a pine bough with the leaves left on. On a



FIG. 42.—Pea pod-spot.

warm sunny day they are killed by the hot ground on which they fall, and few, if any, ever return to the plants.

## PEA WEEVIL.

Seed peas are often found with a single round hole in each made by a pea weevil or pea "bug." This insect is about one-fourth inch long and is thickly covered with brownish scales with black and white markings. Often every pea in a pod, when prepared for the table, will be found infested with a weevil. In dry seed the chamber under the skin in which the insect lives can be seen plainly. Many seeds that have been attacked will start to grow, but the plants are likely to be weak. Since this weevil has only one brood a year, it is treated more easily than is the bean or cowpea weevil.

*Prevention.*—If you raise your own seed, keep it in a warm room in a tight bag or box for one full season before planting. The weevils will come out of the seed so kept and die. Do not plant seeds that have been injured by weevils.

#### FOUR-SPOTTED BEAN WEEVIL AND COWPEA WEEVIL.

The four-spotted bean weevil and the cowpea weevil are similar in appearance and habits. They prefer cowpeas as food, but in the South attack also table beans, chickpeas, and peas, in fact, all such seeds sufficiently large to sustain a single larva. They differ from the true pea weevil in that they are capable of producing several broods each season in dry seeds.

*Treatment.*—Fumigate with carbon disulphide, or, if the seeds are not to be used for planting, place in a shallow pan and bake in an oven for 5 to 10 minutes.

#### POTATO.

##### SCAB.

Common scab (fig. 43) appears as rough-pitted spots on the potato tubers and is due to a soil fungus. Severely attacked potatoes are covered with scabs, which cause waste in paring. The disease lives in the soil and is also carried on the tubers.

*Treatment.*—The control of scab is entirely preventive.

*Prevention.*—If possible, plant on land known to be free from scab infestation. Do not use lime, fresh stable manure, or wood ashes for fertilizer on infested land where potatoes are to be planted. Flowers of sulphur or finely ground sulphur broadcasted, one-half to 1 pound per 100 square feet, has given control on some soils, though it may cause injury to certain other crops in the rotation, especially crucifers. Do not plant badly scabbed seed, and treat all seed potatoes, just before cutting, in formaldehyde or mercuric-chloride solution (p. 40).



FIG. 43.—Potato scab; tuber unfit for planting.

##### LATE-BLIGHT.

In years when cool moist weather occurs during late July and August, late-blight often causes great losses, particularly in the Northern States. The disease attacks the leaves and stems, causing irregular dead areas (fig. 44), killing the plants prematurely and reducing the yield. In moist weather the disease spreads very fast, killing the plants in a few days. Later, it produces a brown rotting of the tubers (fig. 45), which continues in storage.

*Treatment.*—Late-blight can be controlled by carefully spraying the plants with 4-4-50 Bordeaux mixture, beginning when the disease is first seen. Repeat the spraying every 10 to 14 days in dry weather and every 7 to 10 days in moist weather.

Great care and thoroughness must be used to keep the foliage covered at all times with a thin film of the spray mixture. Potatoes showing rot at digging time should not be stored with the sound ones.

*Prevention.*—Select tubers free from late-blight rot for planting, since the disease lives over winter in the diseased potatoes.

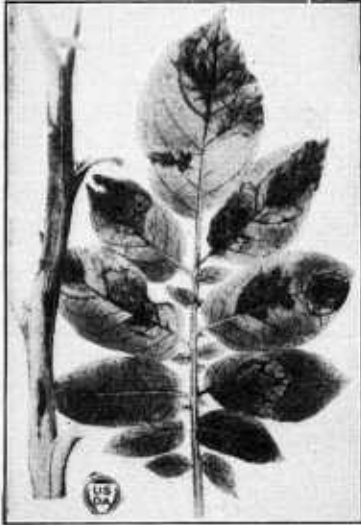


FIG. 44.—Potato leaves and stem, showing injury by late-blight.

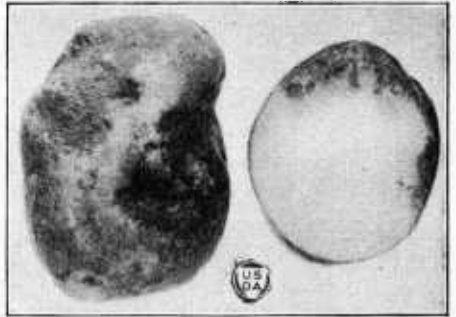


FIG. 45.—Potato tubers affected with late-blight rot.

#### EARLY-BLIGHT.

This fungus trouble usually appears in early July in the Northern States, causing on the leaves dark roundish to irregular spots with

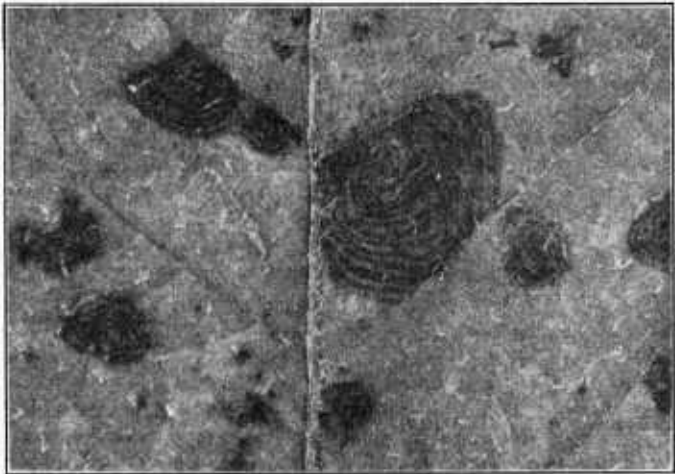


FIG. 46.—Early-blight spots on potato leaf (considerably enlarged to show target-board markings).

characteristic target-board markings (fig. 46). Moist warm weather is most favorable for its development.

*Treatment.*—Spray as directed for late-blight control.

## WILT AND DRY-ROT.

The wilt, due to fungi in the water-vessels, is marked by a yellowing and drooping of the foliage in hot weather and slow wilting of the plants, resulting in reduced yields. The interior of the stems and tubers shows a brown ring (fig. 47), and the disease is carried in the tubers.

*Treatment.*—No treatment can save affected plants.

*Prevention.*—Seed potatoes showing any internal discolorations should be discarded. Use only the best disease-free seed. A long rotation helps to reduce the disease in the soil. Where the disease is bad, the use of whole small tubers is preferable to cut seed, provided they are known not to have come from weak or diseased plants.

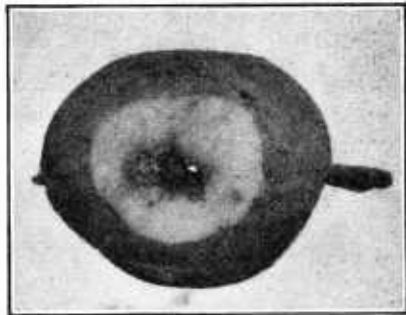


FIG. 47.—Potato stem-end browning due to wilt.

## MOSAIC AND LEAF-ROLL.

Mosaic and leaf-roll belong to a group of so-called "virus diseases" which are known to be carried in the tubers from diseased plants and to be spread by insects, even though their exact cause has not yet been discovered. They are the most serious potato diseases, by reason of the marked reduction in yield which they cause and also on account of the difficulty of securing healthy seed, which are essential to the production of a healthy crop.



FIG. 48.—Potato mosaic on leaf.

Mosaic is characterized by light and dark green mottling of the leaves, often accompanied by wrinkling and dwarfing (fig. 48) and in severe cases by pronounced stunting of the plants.

Leaf-roll is recognized by the yellowing and dwarfing of the plants and the upward rolling of the lower leaves, whose texture is leathery to the touch (fig. 49).

*Treatment.*—The control of plant-lice will delay the spread of these diseases.

*Prevention.*—The use of seed free from disease is the only known control measure. Many States have a potato-inspection service, and growers whose fields, as shown by one or more inspections, are sufficiently disease free are given a certificate and are allowed to sell their

crop as "certified seed." This "certified seed" is usually better than ordinary seed, giving larger yields of healthier tubers.

#### COLORADO POTATO BEETLE.

If careful watch is not kept this insect (fig. 50) is sure to injure the crop. The beetle and its "slugs," the young or larvæ, are well known. Both "slugs" and beetles feed on the potato plants. After passing the winter in the ground, the beetles appear about the time the potatoes come up, lay their eggs on the under sides of the leaves, and begin feeding. They often destroy small patches in the garden. The beetles sometimes feed also on eggplants and tomatoes. There are from one to three broods a year.

*Treatment.*—Arsenate of lead is the best remedy.

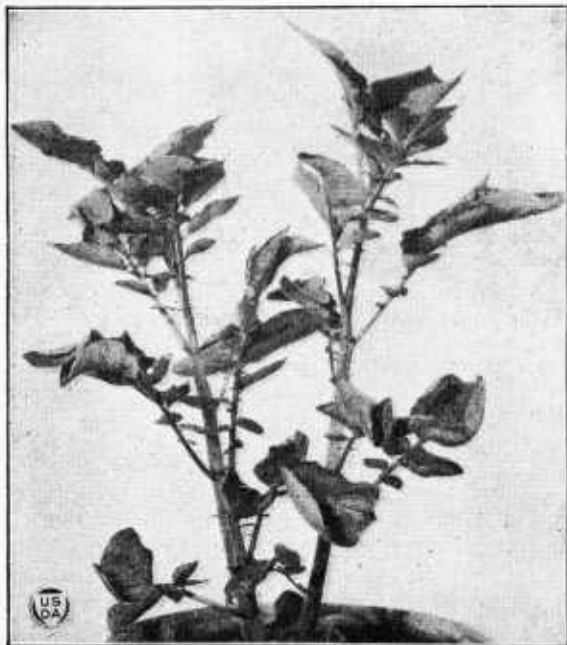


FIG. 49.—Potato leaf-roll.

Colorado potato beetle as potato pests. They are slim, somewhat soft-bodied insects of different colors, sometimes striped, that feed on all kinds of vegetables, seeming to prefer potatoes, after which they attack beans, peas, beets, cabbage, and other plants. They are sometimes called "old-fashioned potato bugs."

*Treatment.*—Lead arsenate is the best remedy.

#### FLEA-BEETLES.

Small round holes in the leaves of potato and various related crops, such as tomato and eggplant, show the presence of flea-beetles.

*Treatment.*—Lead arsenate put on as a spray is the best remedy, especially if stirred into Bordeaux mixture. Bordeaux mixture alone is an excellent spray to drive the beetles away. Spray both sides of the leaves.

#### BLISTER BEETLES.

Blister beetles rank next to the Col-

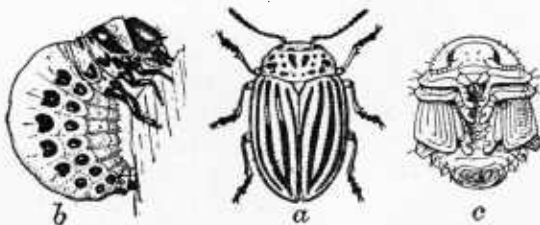


FIG. 50.—Colorado potato beetle: a, Beetle; b, larva or "slug"; c, pupa. (Chittenden.)

## SWEET POTATOES.

## STEM-ROT.

Stem-rot occurs nearly everywhere sweet potatoes are grown. It is due to a fungus which grows in the water vessels, causing a yellowing and wilting of the plants and reduction in the yield. Stems from such plants are black inside, and the potatoes show a black ring (fig. 51) and if used for bedding next season will produce diseased plants.

*Prevention.*—The home gardener in buying sweet-potato plants should make sure they are sound and healthy with clean, white roots and stems, and should plant them on land not in sweet potatoes the year previous. Those who grow



FIG. 51.—Section showing stem-rot in sweet potato and in sprouts.

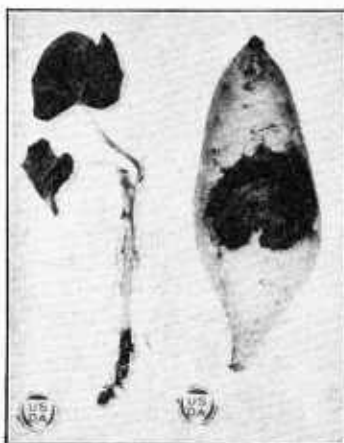


FIG. 52.—Sweet potato and slip, showing black-rot.

plants for large fields should secure Farmers' Bulletin 1059, which gives directions for growing healthy plants.

## BLACK-ROT.

Black-rot is a widespread fungous disease causing roundish, black, sunken spots of varying size on the potatoes and black cankers on the stems or underground parts (fig. 52). The disease is carried in the seed and readily attacks the slips. Black-rot spreads freely in storage, and affected potatoes have a bitter taste when cooked.

*Prevention.*—The same as for stem-rot.

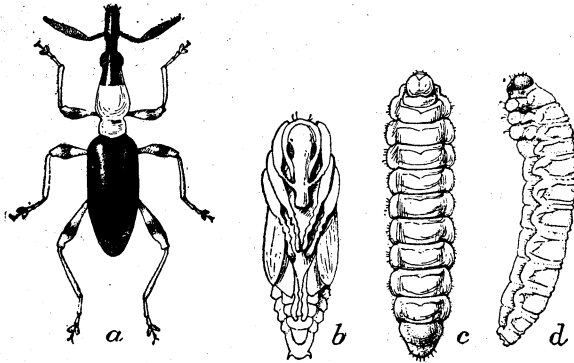
## SWEET-POTATO WEEVIL.

In some parts of the Gulf States sweet potatoes are often attacked by a small antlike beetle with a bluish green body and red legs and head (fig. 53). This pest is about one-quarter inch long and produces a whitish larva, or grub, slightly larger in size, which by tunneling through sweet-potato tubers renders them unfit for food.

Several broods may be produced each year. While this weevil works in the field it continues its injuries in the storehouse.

**Prevention.**—Carefully sort all sweet potatoes, throwing aside or using immediately those showing the work of the weevil. Plant only uninfested tubers for the slip bed. Carefully clean out all old

vines and remnants from last year's field, destroying them by burning. Plant the new field as far from the old one as possible. Consult Farmers' Bulletin 1020 for full directions for reducing injury by this pest.



TORTOISE BEETLES.

FIG. 53.—The sweet-potato weevil: a, Beetle; b, pupa; c, larva, view of back; d, larva, side view. Much enlarged.

There are several kinds of small beetles (fig. 54), shaped much like turtles, which feed on sweet potatoes. Some are golden, marked with black. They and their young eat the leaves. The young are peculiar spiny grubs with long forked tails, which they carry over their backs loaded with dirt for protection.

**Treatment.**—The grower need not spray for these pests unless they become serious. In that case use arsenate of lead.

#### TOMATO.

##### WILT.

The widespread and serious tomato disease known as wilt is caused by a fungus which enters the roots from infested soil, grows into the water vessels, and produces an upward rolling of the leaves, followed by gradual yellowing, wilting, and death of affected plants (fig. 55). The fungus which causes the disease lives in the soil and is also carried in the seed.

**Prevention.**—Use wilt-free seed and wilt-free soil for growing plants, disinfecting the soil if necessary. If the home garden has become infested with wilt, plant only wilt-resistant varieties. Several excellent varieties of wilt-resistant tomatoes, namely, Norton, Norduke, Marvel, Columbia, Marglobe, and Break o' Day, have been developed by

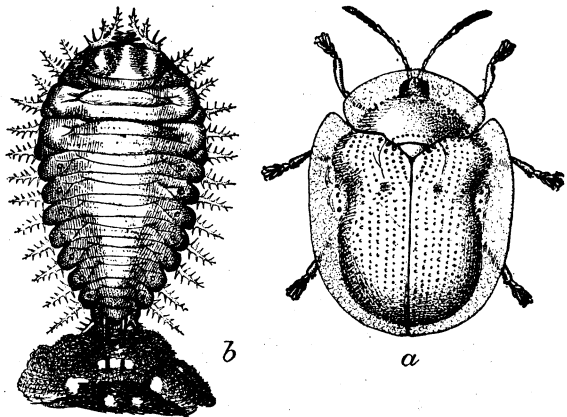


FIG. 54.—The golden tortoise beetle: a, Beetle; b, young. Greatly enlarged. (Chittenden.)

this department and are now listed by seedsmen. They produce large crops of fruit on soil where most other varieties are destroyed by wilt.

#### LEAF-SPOT.

Leaf-spot is caused by a fungus which attacks the leaves and stems, causing small circular spots with light centers and dark margins (fig. 56). It starts on the lower leaves and progresses upward, causing them to curl, dry up, and fall off, leaving the stems bare except at the tips. This defoliation results in a reduced yield and poor quality.

*Treatment.*—Spray thoroughly with Bordeaux mixture (p. 39), beginning as soon as the plants are set out and repeat every 10 days.

*Prevention.*—Set only healthy plants. Rotate crops, and plow under old tomato vines in the fall.



FIG. 55.—Tomato wilt (late stage), showing dead leaves and stems and unfruitfulness.



FIG. 56.—Tomato leaf-spot.

#### BLOSSOM-END ROT.

This disease causes large, dark, sunken spots on the blossom end of the green fruits (fig. 57). Its cause is not well understood, but it appears to be connected with soil conditions, particularly with the water supply.

*Treatment.*—Watering the plants during very dry weather has been found helpful in controlling blossom-end rot. Frequent cultivation is also of assistance.

*Prevention.*—The plowing under of stable manure, green manure, or other vegetable matter will increase the water-holding power of the soil and thus reduce injury from blossom-end rot.



## TOMATO WORMS, OR HORNWORMS.

Certain large green caterpillars are also called tobacco hornworms or tobacco worms, as they feed on both tomato and tobacco plants. There are two different species, of very similar appearance, one of which is shown in Figure 58. They are the young

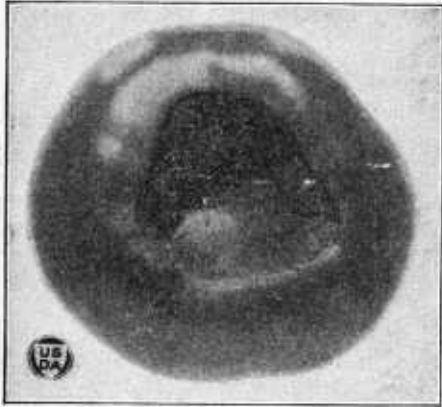


FIG. 57.—Blossom-end rot of tomato.

of large humming-bird moths. In spite of the wicked-looking horn on the tail, they are entirely harmless to persons. A single hornworm, when large, can strip a tomato plant in two or three nights, leaving only the stems. There are two broods in a season. The gardener should be on the lookout for the first as well as the second brood.

*Treatment.*—Hand picking is the best remedy. Sharp eyes are needed to see the worms when they are not moving, since they are the

same color as the stems on which they rest during the day. They may often be discovered by their voidings. When feeding they are more readily seen and can be easily killed. A single dose of lead arsenate will kill them.

*Enemies.*—Tomato hornworms will often be found carrying many small white objects on their backs. These are not eggs of the caterpillar, as many believe. The caterpillar is incapable of laying eggs. The white objects are the cases or cocoons from which come small parasitic insects which prey entirely upon the hornworms and are one of the most effective natural controls for these pests. Do not destroy

the hornworms bearing these cocoons, as the killing of the parasites thus occasioned prevents continuation of their good work, particularly since the caterpillars do no feeding after the parasites begin to come out.

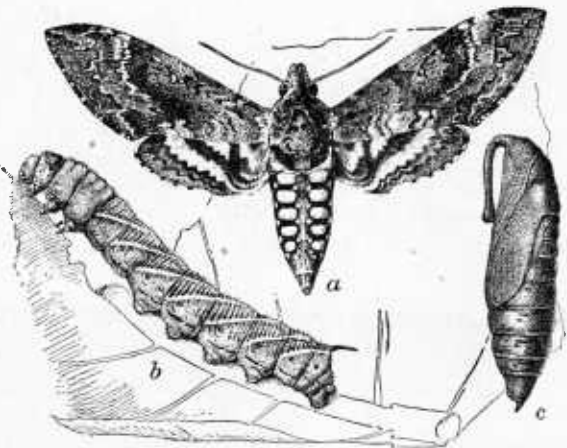


FIG. 58.—Tomato hornworm: *a*, Moth; *b*, hornworm; *c*, chrysalis. About one-half natural size. (Howard.)

## TOMATO FRUITWORM.

The tomato fruitworm (fig. 59), also called the corn ear worm, is the cause of much trouble to tomato growers, as it eats into the ripening fruit and destroys it.

*Treatment.*—Lead arsenate applied two or three times will keep the insect partially under control. As long as sweet corn is near by, the worms will let the tomatoes alone. Hand picking is good in small gardens.

## FLEA-BEETLES.

The potato flea-beetle frequently attacks tomatoes and does much damage.

*Treatment.*—Dip the young plants in a mixture made up of  $1\frac{1}{2}$  ounces of lead arsenate and 1 gallon of water before setting them out. Spraying with Bordeaux mixture will drive the beetles away.

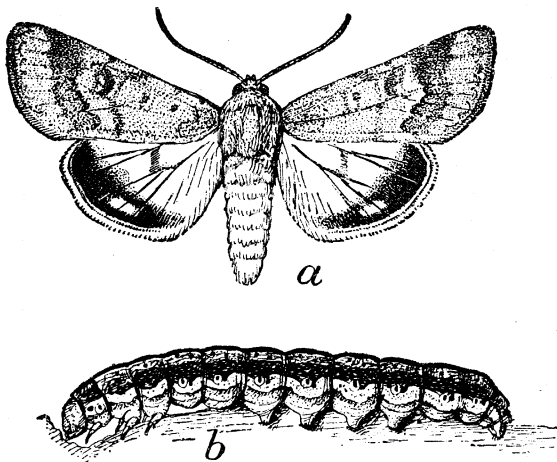


FIG. 59.—Tomato fruitworm: a. Moth; b. full-grown fruitworm. (Chittenden.)

## HOW TO MAKE FUNGICIDES AND INSECTICIDES.

Fungicides are materials used to kill bacteria and fungi which cause plant diseases.

Insecticides are materials used to kill insects which attack plants.

## FUNGICIDES.

## BORDEAUX MIXTURE.

Bordeaux mixture is the best spray mixture for controlling leaf diseases of garden plants and as a deterrent against flea-beetle attack. It is very important that gardeners realize that this mixture is a preventive and not a cure and that consequently it must be applied before or as soon as the very first signs of disease are seen. It can be purchased in convenient packages from seed dealers, or a better spray can be made more cheaply at home as follows:

Bluestone (copper sulphate), 4 pounds	} or {	4 ounces.
Quicklime (stone lime), 4 pounds		4 ounces.
or hydrated lime, 6 pounds		6 ounces.
Water, 50 gallons		3 gallons.

Dissolve the bluestone in a wooden or earthenware vessel, using hot water. Dilute with half the water. Slake the lime in a small quantity of water; then dilute with the rest of the water. Pour the diluted bluestone and lime solutions together, straining them through a fine cheesecloth or brass-wire strainer, and mix thoroughly. It should be made fresh each time used, as it does not keep well.

Since stone lime air-slakes rapidly and is then no longer good for Bordeaux mixture and also is often difficult to get at short notice,

it is best to make up a stock solution of lime containing 1 pound to each gallon of water. This will keep indefinitely if not allowed to dry out. A stock solution of bluestone can also be made by dissolving 1 pound of the copper-sulphate crystals in a gallon of water. One quart of each of these stock solutions is equivalent to the 4 ounces of lime and bluestone given in the formula. The stock solutions may be stored in old glass jars or other containers until needed. Dilute each with half the required quantity of water before mixing. Where biting insects, such as potato beetles, are to be controlled, as well as diseases, add 4 ounces of lead-arsenate paste or 2 ounces of powdered lead arsenate to the above 3-gallon formula for Bordeaux mixture.

#### BORDEAUX DUSTS.

Several Bordeaux dust mixtures are on the market for the control of plant diseases. They have the advantage of being more quickly and easily applied than sprays, and they do away with the requirement for carrying water necessary for spraying. Under conditions of moderate infection fairly satisfactory results have been secured, but in severe outbreaks of diseases which progress rapidly more complete control has been obtained by thorough and timely spraying with homemade Bordeaux mixture.

#### MERCURIC CHLORIDE.

Mercuric chloride (corrosive sublimate) is commonly used for treating seed potatoes and cucumber and cabbage seed for disease control. It is most conveniently purchased at drug stores or agricultural supply houses in the form of tablets costing about 25 cents for 24. For the purposes here advised a 1 to 1,000 solution is used. This is made by dissolving two large tablets in a quart of water. For larger quantities use at the rate of 1 ounce to 8 gallons of water.

For potatoes soak for half an hour to disinfect for scab and black scurf. Treat cucumber seed for five minutes, stirring frequently, and then rinse thoroughly in running water, for the control of angular leaf-spot and anthracnose.

For cabbage seed soak 30 minutes and then rinse in clean water.

While this substance is of particular value in the treatment of seeds for disease, it is also applied against the root-maggots that attack cabbages, radishes, and similar crops. The same proportions are used as for plant-disease treatment. Pour the mixture at the bases of the plants as soon as set out, or in the case of radishes and other row crops immediately along the rows with a watering can. Root-maggot injury can be almost entirely prevented by a solution of corrosive sublimate used in this way.

*Since mercuric chloride is a deadly poison*, great care must be taken to keep it out of the reach of children and farm animals, and no seed or tubers treated in it should be fed to any animals or human beings. Since it attacks metals, only wooden, glass, or earthenware vessels should be used in making the solution or treating the seed.

#### FORMALDEHYDE.

Formaldehyde (formalin) is also used for treating seed potatoes, onion seeds, and soil to prevent diseases. It is a clear solution of 37 per cent formaldehyde gas in water, which retails for about

50 cents a pint. It is very irritating to the eyes and to cuts and has a very drying effect on the skin, but is not poisonous. It does not attack metals. For most purposes use 1 teaspoonful to a pint, 1 ounce to 2 gallons, or 1 pint to 30 gallons of water. For disinfecting seed potatoes for scab soak two hours in the above solution. For soil disinfection drench the soil with a 1 to 200 solution at the rate of three-fourths of a gallon per square foot of area several days before the soil is to be used.

#### INSECTICIDES.

Two classes of insecticides are used for controlling insects—stomach poisons and contact poisons.

Stomach poisons, such as lead arsenate, calcium arsenate, and Paris green, are used for all insects which injure plants by chewing the leaves or stems, like striped cucumber beetles and potato beetles.

Contact poisons, such as pyrethrum, soap, and nicotine sulphate, which kill by touching the insects, are used for sucking insects like plant-lice and squash bugs. Stomach poisons are of no value for sucking insects.

#### LEAD ARSENATE.

Arsenate of lead (lead arsenate) is sold by most druggists and seedsmen both as a powder and as a paste. It is a good remedy for nearly all kinds of pests which eat the leaves of garden plants. It is used either mixed with water as a spray or as a dry powder dusted on plants.

*How to make the spray.*—Take one level teaspoonful of powdered lead arsenate for each pint of water. Mix thoroughly and apply with a sprayer. If lead arsenate paste is used, take two teaspoonfuls for each pint of water to make a spray mixture.

*How to mix dust poison.*—Where a sprayer is not available, a dust may be used. This is made by thoroughly mixing 1 pound of powdered lead arsenate with 3 pounds of air-slaked or powdered lime. This mixture is put into a cheesecloth bag and dusted onto the plants by shaking the bag lightly over them.

#### OTHER STOMACH POISONS.

Other stomach poisons, such as calcium arsenate, magnesium arsenate, Paris green, and zinc arsenite, may also be bought from dealers. These are used like lead arsenate. Directions for making the mixtures will be found on the packages.

#### NICOTINE SULPHATE AS A SPRAY.<sup>4</sup>

For small gardens use a teaspoonful of nicotine sulphate in a gallon of water. A 1-inch cube of hard soap should be shaved up and thoroughly mixed into the solution. Full directions for mixing are given on the covers of the packages. For large aphids, like the pea aphid, a little more nicotine sulphate than stated above should be used. By looking carefully at the freshly sprayed plants, one can tell whether there is enough soap in the mixture. If the spray draws together in drops, more soap should be added. When possible fish-

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<sup>4</sup>A solution containing 40 per cent of nicotine by weight.

oil soap should be used, but cheap laundry soap will do. If the nicotine-sulphate solution has stood for any length of time, it should be mixed thoroughly before using. The insects themselves must be wet by the spray or they will not be killed. Therefore the spraying should be very thorough and should be done as soon as the insects are noticed.

#### NICOTINE SULPHATE AS A DUST.

Nicotine sulphate is also useful combined with a dry carrier whenever it is preferable to use this form of application and is available commercially in this form from several manufacturers. For home use it may be prepared by adding the required proportion of nicotine sulphate to finely pulverized air-slaked or hydrated lime.

A good proportion for small gardens is 12 pounds of lime and 8 ounces of nicotine sulphate,<sup>5</sup> which will make a mixture containing

1.6 per cent of nicotine or 4 per cent of nicotine sulphate, the strength most useful against most common garden insects. It is necessary that the nicotine sulphate be thoroughly mixed with the lime. Add to the lime the required quantity of nicotine sulphate slowly from a can with a perforated top. A pint fruit jar with a metal top punched full of holes with a sixpenny nail makes a good sprinkler. After adding the nicotine sulphate, run the mixture through a fine sieve, 20 meshes to the inch, with the aid of a brush.

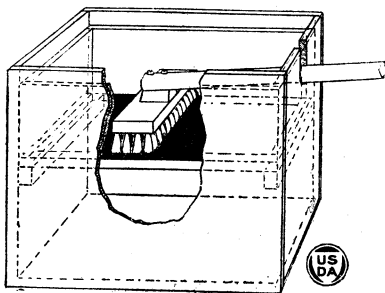


FIG. 60.—A mixer for use in preparing small quantities of nicotine dust.

Repeat this operation three times. Be sure that all the material is worked through the sieve, as otherwise nicotine may be lost. The accompanying illustration (fig. 60) shows the construction of a suitable mixing box, in which an ordinary floor brush with a broom handle attached may be used as a convenient mixer. The handle should be attached at right angles to the brush and the box has a slotted side so arranged that the brush will rest level over the entire length of the sieve. A tight-fitting cover prevents the escape of the dust and consequent inconvenience to the operator. A box 15 inches long, 10 inches wide, and 12 inches deep is employed for the preparation of the quantity of dust before mentioned. The sieve is made of brass screen, 20 meshes to the inch, tacked to a frame 4 inches deep, and fits snugly inside the box on a strip  $5\frac{1}{2}$  inches from the upper edge. In the drawing (fig. 60) a portion of the box is shown cut away in order that the inside construction may be seen. For the treatment of only a small planting, 1 or 2 pounds of nicotine dust may be prepared by using an ordinary household flour sifter, maintaining, of course, the same proportions of nicotine and hydrated lime. Be sure that all lumps are broken up and passed through the sifter, and resift at least three times to insure a thorough mixture. This mixture, prepared according to directions, is a satisfactory dust for use against plant-lice and the striped cucumber beetle. For the latter the ground around the

<sup>5</sup> Containing 40 per cent of nicotine by weight.

the plants, as well as the plants themselves, should be thoroughly whitened with the dust when the insects make their first appearance. A single application is usually successful, but the treatment may be repeated as often as required.

Nicotine dust must be preserved in tight metal or glass containers, as it loses its strength very rapidly when exposed to the air.

#### SOAP SPRAYS.

Ordinary soapsuds is a good spray for plant-lice and leafhoppers. It should be made by dissolving a 1-inch cube of laundry soap or a rounded tablespoonful of whale-oil or fish-oil soap in a quart of hot water. This also must reach the bodies of the insects in order to kill them. This spray must not be used full strength on very tender plants, such as young cabbage or cauliflower in seed beds, garden peas, or young beans, as it will injure the leaves. Use half strength for these plants.

#### PYRETHRUM POWDERS AND EXTRACTS.

The insect powders sold as buhach, Persian insect powder, and Dalmatian insect powder are composed of the finely pulverized flower heads of three species of Chrysanthemum. The active poison which they contain is a volatile oil which is much more poisonous to insects than to the higher animals. This oil forms the basis for a large number of commercial fly and household sprays and has recently been placed on the market as a contact insecticide for use against garden and greenhouse insects. It has the advantage of being practically non-poisonous to human beings in the dilutions used against insects, and may safely be applied to such crops as greens, snap beans, cabbage, and celery up to the time of gathering. Either the pyrethrum powder itself or the extracts made from it may be used. They should be kept in tight containers while stored, as they lose strength rapidly by exposure to the air. In applying them, they must actually touch the bodies of the insects against which they are used. Follow the directions of the manufacturer as to the application, as the concentration of the commercial preparations varies greatly.

#### HOW TO SPRAY.

To be successful in the control of diseases and insects the spray mixtures must be properly made, and spraying must be done promptly and thoroughly. Do not wait until the plants have been seriously injured, but begin to spray as soon as the trouble is first seen. Use good apparatus and spray carefully. Using a watering pot or whisk broom is not spraying and is a hit-or-miss method which covers the plants only partially. The ideal spray is a fine mist, and the best work is done when the entire plant is thoroughly and evenly covered with very fine drops. Stop spraying before the foliage is drenched. The higher the pressure the better the spray.

Spraying with Bordeaux mixture should be done before rains rather than after, provided the spray has time to dry on the leaves. The intervals between spray applications should depend on the weather. If it is rainy or muggy, with fogs and heavy dews, these conditions are favorable for diseases, and spraying should be done more frequently to keep the foliage protected at all times. If dry, longer intervals may be allowed between sprays.

## SPRAYING AND DUSTING TOOLS.

The sprays and dusts described may be put on in many ways. For the small garden an atomizer sprayer (fig. 61) is good, but a compressed-air sprayer is better for gardens of medium size (fig. 62).

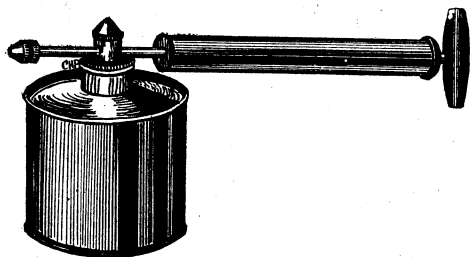


FIG. 61.—A small atomizer suitable for small gardens.

The container for the liquid in the sprayers should be made of glass, brass, or galvanized steel, as Bordeaux mixture and other materials corrode tin and iron.

Dusts may be easily applied for insect control by shaking them from a fine cheesecloth bag or from a can with a handle and the bottom perforated with very small holes. Several small cheap but effective dust guns are on the market (fig. 63).

## MISCELLANEOUS CONTROL METHODS.

## SOIL DISINFECTION.

Young plants grown in flats or boxes for setting in the garden are often troubled with damping-off (p. 6) and cabbage with clubroot (p. 13). The organisms which cause these diseases live in the soil and will be carried on the diseased plants into the garden. The best way to get rid of them is to treat the soil a few days before planting the seeds, either with boiling water or formaldehyde solution or by steaming.

If the first method is used, set the flat or box of soil over the sink and pour the boiling water into it as fast as the soil will take it up. Use 9 quarts of water for a box 1 foot square with soil 4 inches deep. When the soil has dried out enough plant the seeds. In this treated soil seeds will sprout better and plants grow faster and stronger than in untreated soil.

For directions for using formaldehyde solution, see under "Formaldehyde" (p. 40).

The pressure cookers or steam sterilizers used for canning purposes are excellent for sterilizing small quantities of soil to kill insects and diseases or the soil may be thoroughly baked in a pan in the oven.

## LIME.

Lime is used in several forms in plant-disease control. Quicklime or stone lime in lump form, as commonly used for making plaster, is

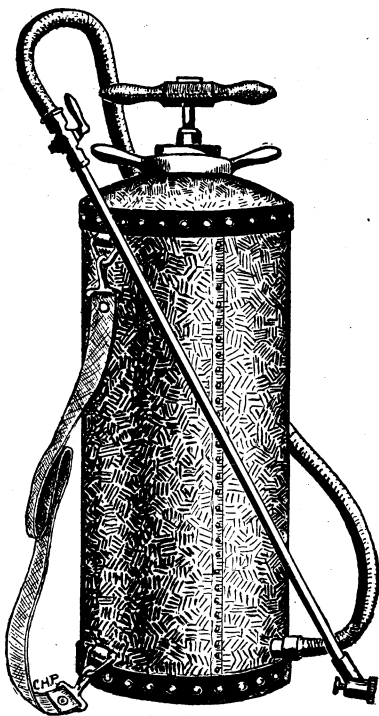


FIG. 62.—A compressed-air sprayer suitable for larger gardens.

used for slaking to make Bordeaux mixture. When it becomes air slaked from long standing it is of no value for this purpose.

For applying to land to correct too great acidity air-slaked or hydrated lime is the best form to use. Ground limestone is also used. Its action is slower, and it may be applied in larger quantities without injury to the soil. For the control of cabbage clubroot apply hydrated lime at the rate of 25 pounds to the square rod. Do not apply lime to land to be planted in potatoes since it will tend to increase scab injury.

Air-slaked lime will also keep away certain insects, and is a good remedy for slugs.

#### FLOWERS OF SULPHUR.

Flowers of sulphur is used to apply broadcast on land which is infested with potato scab to increase the acidity of the soil and thus reduce the damage from scab. For the control of the red spider and for some other kinds of mites, sulphur may be either dusted on plants or mixed with water, a teaspoonful of sulphur to a quart of water, and sprayed.

#### CARBON DISULPHIDE.

Carbon disulphide is a clear yellowish liquid with a bad odor. It is used for treating seeds to kill weevils and other insects which breed in them. A tin bucket or can fitted with an air-tight top makes a good fumigator. The seed should be placed in the bucket or can and the carbon disulphide poured on a piece of rag or waste

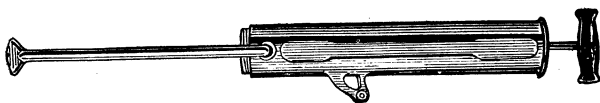


FIG. 63.—A powder gun for applying dust mixtures in a small garden.

cotton and dropped upon the seed. A teaspoonful of carbon disulphide is sufficient for a 1-gallon can or bucket. The lid should then be fitted tightly onto the can or bucket and left for 24 hours. The seed should then be removed and aired.

*Carbon disulphide is a dangerous explosive when brought near fire.*

#### TRAP CROPS.

Some garden insects which feed on several kinds of plants prefer one kind so much that they will leave the other plants and gather on the favorite. Advantage of this habit can often be taken to protect garden crops. For example, a row of radishes may be planted next to cabbages to attract the cabbage maggot. Horseradish or mustard will attract the harlequin cabbage bug from cabbage. A crop planted in this way to protect another by attracting the insect pests from it is called a trap crop, as the insects thereby attracted may be destroyed with the crop after it has served its purpose.

#### BENEFICIAL INSECTS.

##### LADYBIRD BEETLES.

There is a widespread belief that the small red ladybird beetles, an example of which is illustrated in Figure 64, together with the



younger stages, are the parents of injurious plant-lice, on account of their abundant association with these pests during the growing

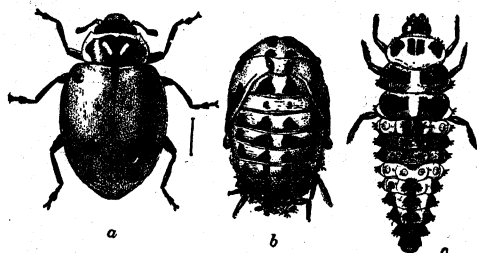


FIG. 64.—A ladybird: *a*, Beetle; *b*, pupa; *c*, young. These beetles and their young eat dozens of plant-lice each day. (Chittenden.)

season. This is not true, as the ladybird beetles are one of the best natural controls against the multiplication of aphids. A well-grown or adult ladybird requires 50 to 80 plant-lice for its daily meal. The beetles should therefore be encouraged so far as possible, as they are among the grower's best friends. They also eat the eggs of many injurious insects.

#### SYRPHUS FLIES.

Other curious insects often associated with plant-lice are green sluglike maggots, often marked with whitish stripes and about one-half an inch long. These are the young of small yellow black-

banded flies (fig. 65) that may be found about "lousy" plants and are known as syrphus flies. They should be protected, as they are among the most energetic enemies of plant-lice.

Many other insects, among which are ground beetles, lace-wing flies, and tachina flies, are of benefit to the grower, who should learn to recognize them.

As a matter of fact, were not the efficiency of predacious insects so great, our crops would be a complete loss through attacks of plant-feeding insects, which would soon increase to such a point that no vegetables would be left to feed upon.

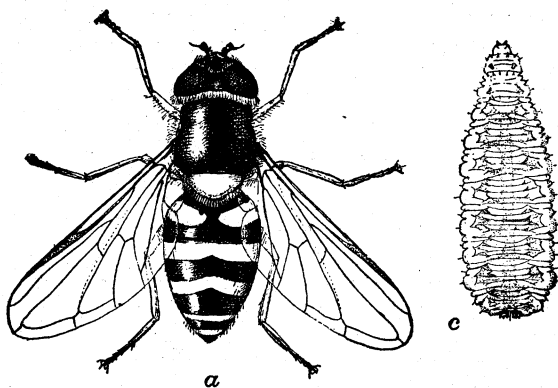


FIG. 65.—A syrphus fly: *a*, Fly; *c*, maggot. This fly helps keep down plant-lice. It is about the size of a common house fly. (Chittenden.)